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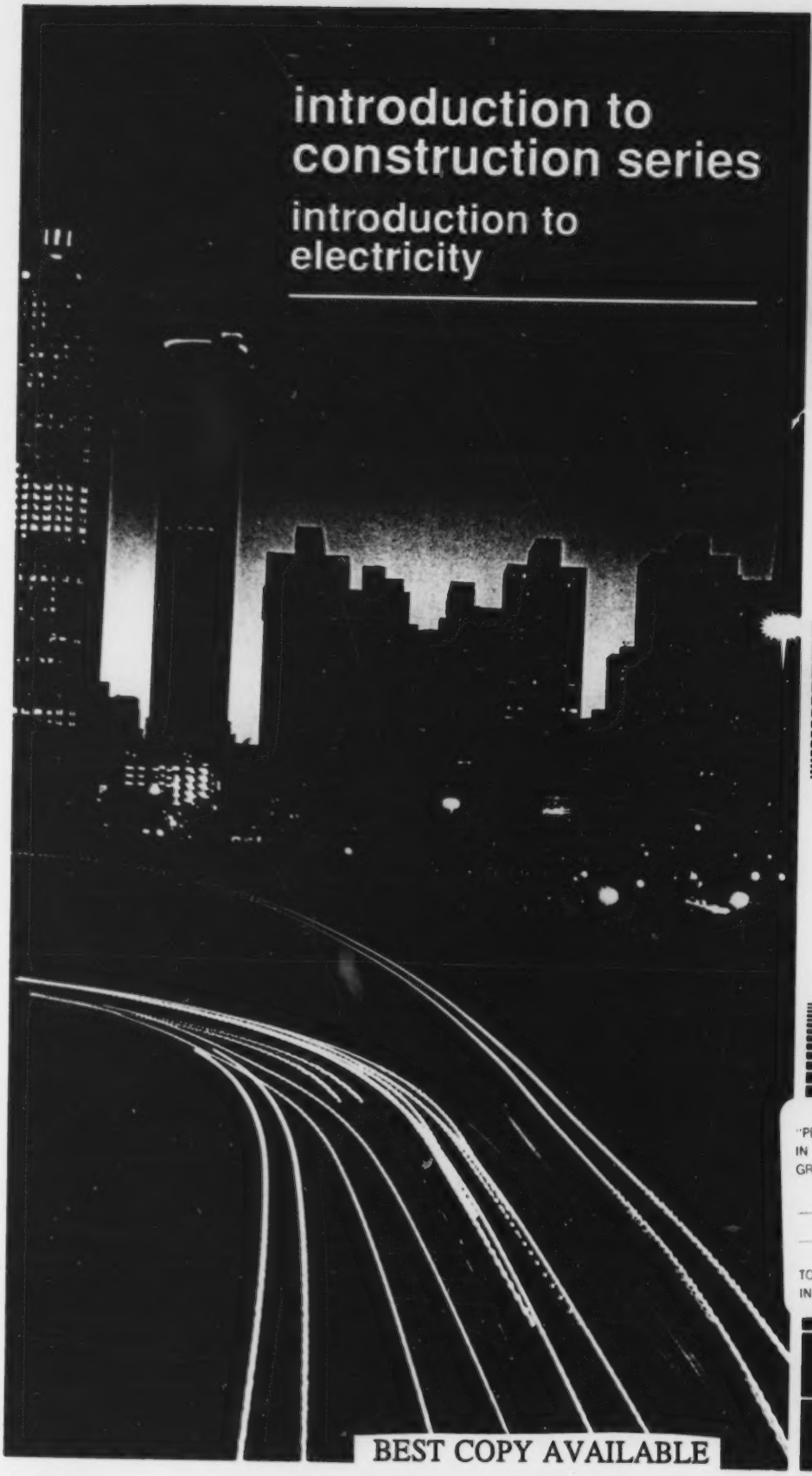
ABSTRACT

This instructor's guide contains the materials required to teach a competency-based introductory course in electricity to students who have chosen to explore careers in construction. It contains three units: electricity materials, electricity tools, and applied skills. Each instructional unit includes some or all of the basic components of a unit of instruction: performance objectives, suggested activities for the instructor, extensions and options, information sheets, student supplements, transparency masters, instructional supplements, assignment sheets, job sheets, practical tests, written tests, and answers to assignment sheets and written tests. Academic skills training is combined with vocational training throughout the instructional materials, and a system of icons has been used to help instructors identify activities into which training in the following basic skill areas has been infused: reading, science, creative thinking/problem solving, writing, oral communication, employability, math, interpersonal skills, and social studies. Most units of instruction are designed for use in more than one lesson or class period of instruction. These materials precede the instructional units: information on basic skills in curriculum, information on measuring student performance gains, and required criteria for a competency-based education program. A basic skills documentation matrix and competency profile are provided. (YLB)

ED 385 687

introduction to construction series

introduction to electricity



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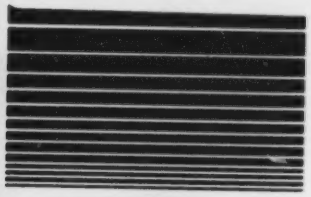

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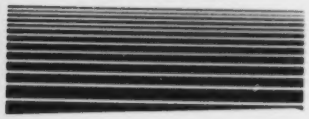

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95-010909

Introduction to Electricity

Developed as a Cooperative Project by
the Associated General Contractors of America
Steve Hoech, Chairman, Manpower and Training Committee
and
Curriculum and Instructional Materials Center,
Oklahoma Department of Vocational and Technical Education

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Introduction to Electricity

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FOREWORD

In 1985, The Associated General Contractors of America (AGC) met with representatives of the Oklahoma Curriculum and Instructional Materials Center (CIMC) to discuss the possibilities of developing, as a cooperative project a course of instruction designed for training individuals who choose to seriously explore careers in construction.

This revised publication is the result of those original discussions and updates made through close coordination among general contractors and vocational educators. This series represents conscious effort to coordinate the practical experience of personnel in the carpentry industry with the best instructional methods of those in the field of vocational education.

Although this book reflects a systematic approach to instructional materials development and the latest in educational technology innovations, the information in the Introduction to Electricity manual should be adapted and modified to coincide with local conditions.

Roy Peters, Jr.
State Director
Oklahoma Department of Vocational
and Technical Education

Steve Hoech, Chairman
Manpower and Training Committee
The Associated General Contractors
of America

PREFACE

Construction requires that students have many skills and related information to become productive workers in this challenging field. Workers must be better trained and equipped to find and retain meaningful employment.

Instructional materials in this manual is written in terms of student performance, using measurable behavioral learning process. Criterion-referenced evaluation instrument provide for a uniform measurement of student progress.

The purpose of this manual is to assist instructors in all construction related areas in providing instruction throughout the industry. Any information in this manual that does not concur with the instructor's course of study should be modified to meet personal needs.

Personnel safety is of prime concern, as an instructor you are encouraged to closely observe and couch students in all safety issues. We have done much to advise students of possible dangers, but your close supervision and alertness can't be overemphasized.

Al Willey
Curriculum and Instructional
Materials Center
Oklahoma Department of Vocational
and Technical Education

ACKNOWLEDGEMENTS

Much appreciation is expressed to the many individuals who contributed their time, talents, and knowledge in the revision of this manual.

Thank you to the following ad hoc committee members, AGC staff representatives, and the staff of the Oklahoma Department of Vocational and Technical Education.

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USE OF THIS PUBLICATION
INSTRUCTIONAL UNIT

Introduction to Electricity contains three units. Each instructional unit includes some or all of the basic components of a unit of instruction: performance objectives, suggested activities for the instructor, extensions and options, information sheets, students supplements, transparency masters, instructional supplements, assignment sheets, job sheets, practical tests, written test, and answers to assignment sheets and written test, all of which are included in the instructor's edition. The student workbook includes the objective sheets, information sheets, student supplements, transparency masters, assignment sheets, and job sheets. Written tests may be duplicated for classroom use or *additional copies* may be purchased by calling 1-800-654-4502 or, in Oklahoma, 1-800-522-5810, ext. 589.

All of the unit components tie into measurable and observable learning outcomes. Instructors are encouraged to supplement these components with other resources in order to make them as responsive to local conditions and individual needs as possible.

Most units of instruction are designed for use in more than one lesson or class period of instruction. Careful study of each unit of instruction by the instructor will help him or her determine the following:

- Amount of material that can be covered in each class period.
- Skills that must be demonstrated.
  - — Supplies and equipment needed
  - — Amount of class time needed for demonstrations
  - — Amount of time needed for student practice
- Supplementary materials, including print and non-print media, that must be ordered.
- Resource people who must be contacted.

Objective Sheet (White Pages)

Each unit of instruction is based on the performance needed for successful employment in an occupational area. Performance objectives are stated in two forms. The unit objectives states the overall goal of the unit. It tells what the student should be able to do and what standard will be used to see whether the student can do it. Specific objectives outline the teaching sequence of the competencies required to meet the unit objective.

The objectives should be provided for students and stressed throughout the teaching/learning process. This will help answer any questions concerning performance requirements for each instructional unit. The objectives can also help determine teaching strategies and instructional methods. Instructors should prepare for each unit by deciding how each objective could be best taught.

Instructors should feel free to modify, delete, or add objectives in order to meet the needs of the students and community. When objectives are added, the instructor should remember to supply the needed information, assignment and/or job sheets, and criterion-referenced test items.

Suggested Activities (Pink Pages) — **Instructor's Edition only**

The suggested activities page assists the instructor during the preparation stage of the teaching/learning process by providing suggestions for delivery, application, and evaluation during the instructional process. The instructor should read the suggested activities prior to introducing the unit to allow time to obtain supplemental materials, prepare audiovisual materials, and contact outside resources. Duties of the instructor will vary according to the particular unit.

References used in the development of each unit are listed in the "Suggested Resources" section, along with print and non-print media that may be used to teach the unit. These materials can be used by the instructor to supplement his or her knowledge of the subject area or to help students with particular interests or occupational objectives in the area covered.

Extensions and Options (White Pages) — **Instructor's Edition only**

Extensions and Options are supplemental material that is not testable or graded and is nice-to-know. Extensions and Options provide the instructor with additional activities, fact sheets, art, controversial items, and extra practice sheets. They may also include items for the gifted or remedial student. Extensions and Options are used at the discretion of the instructor.

Information Sheets (Green Pages)

The information sheet provides "must know" content essential for meeting the cognitive objectives stated at the beginning of each unit. It serves as an excellent guide for presenting background knowledge necessary to develop the skills specified in the unit objective.

Students should read the information sheet before it is discussed in class. Space is provided in margins for students and instructors to add notes that clarify and/or expand on the information provided.

The information sheet may include notes, cautions, or warnings. These should be discussed carefully and thoroughly. **Notes** are short verbal additions to the information sheet or procedural outline that provide nice-to-know and decision-making information. A note may tell the student what to watch for or to consider at a given step. It may explain when a step may not be applicable. Notes offer guidance that may help the student understand the process and do it more efficiently. **Cautions** are advisories that tell the student how to avoid causing minor personal injury or equipment damage. **Warnings** are advisories to the student used to avoid serious personal injury or death to the student, persons in the workplace, or users of the project or the procedure.

Student Supplement (Green Pages)

Student supplements include instructions that could be used for solving problems or reinforcing the enrichment of learning. The information presented in a student supplement may consist of tables, charts, written information, forms, or other information students will need in order to complete one or more of the assignment or job sheets. While supplements are not tested over directly, they may be used to assist in meeting the performance objectives.

Transparency Masters (White Pages) — **Instructor's Edition only**

Transparency masters provide information in a special way. The students may see as well as hear the materials being presented, thus reinforcing the learning process. Transparencies may present new information or they may reinforce information presented in the information or assignment sheets.

Transparencies should be made and placed in the notebook where they will be immediately available for use. Transparencies direct the class's attention to the topic of discussion. They should be left on the screen only when topics shown are under discussion.

Instructional Supplements (Pink Pages) — **Instructor's Edition only**

Instructional Supplements provide suggestions for teaching the basic skills included in each assignment sheet or job sheet. They are located directly in front of the components they support—assignment or job sheets—in each unit.

Assignment Sheets (Tan Pages)

Assignment sheets provide students with information and exercises that address learning levels at or above the application level of Bloom's taxonomy. Assignment sheets provide written exercises for instruction and practice of a specific objective. The introduction to the assignment sheet explains how the assignment sheet relates to the subject area and unit component for such information.

Assignment Sheet Answers (Pink Pages) — **Instructor's Edition only**

This component is designed to assist the instructor in evaluating student performance on assignment sheets.

Job Sheet (Blue Pages)

Job Sheets are another important segment of a unit of instruction. The job sheets provide a list of equipment, tools, and materials needed to complete a manipulative or psychomotor skill. They describe a step-by-step procedure to complete each task or job. Diagrams, photographs, and illustration are provided to assist students in achieving the skill.

The instructor should demonstrate the procedure outlined in each job sheet. Furthermore, the instructor needs to localize the procedure according to the equipment and supplies available in the local lab or salon situation. Job sheets also furnish potential employers with a picture of the skills being taught and the performances they might reasonably expect from a person who has had this vocational instruction.

Practical Tests (Yellow Pages) — **Instructor's Edition only**

The practical tests are designed to assist the instructor in the evaluation of the psychomotor activities (job sheets). The practical test provides instructors with a valid mechanism for determining a student's level of ability in performing the procedure stated on the job sheet. The check-off list allows instructors to evaluate a student's process performance of the task on the job sheet. The overall competency indicator allows the instructor to evaluate the end product.

Written Test (Yellow Pages) — **Instructor's Edition only**

This component provides criterion-referenced evaluation of every objective listed in the unit of instruction. If objectives have been added, deleted, or modified, appropriate changes should be made on the test.

In order to measure and document student competency gains as required by the latest Carl Perkins regulations, and as outlined in the Oklahoma-developed system of standards and measures, it is *absolutely essential* that the same test be used as a pretest and as a posttest. If you choose to use tests other than the ones included herein, be sure that the same instrument is used for each activity—pre- and post test.

A detailed explanation of the Oklahoma plan for standards and measures and the Carl Perkins requirements is included in the CIMC publication, *Measuring Learning & Competency Gain: The Pretest/Posttest Approach.* This booklet and accompanying software designed to assist in calculating and recording student gains are available to all vocational teachers through the school's vocational testing liaison.

To further assist vocational teachers, the CIMC is in the process of developing test code sheets for each written test in its more recent publications, including this one. These code sheets are explained in Section 8 of the publication mentioned above, and will greatly assist in verifying that the test is a valid instrument for measuring student learning and competency gains. As the test code sheets for programs become available, they will be forwarded to teachers of each program; further publications will include the test code sheets.

Written Test Answers (Pink Pages) — **Instructor's Edition only**

This component is designed to assist the instructor in evaluating student performance on written tests.

COMPETENCY PROFILES

A competency profile is in the front of each publication. Competency profiles document student performance. The profile contains a list of the specific job competencies that a student should achieve before leaving the training program.

PAGE NUMBERING

Each publication for the Curriculum and Instructional Materials Center is usually assigned a specific abbreviation. ***Introduction to Electricity*** has not been abbreviated. Each unit will be recognized by the unit number in Arabic numerals. Each unit in the publication begins with page 1. Each page number gives the component name, Introduction to Electricity, unit number, and page number within the unit. Since some CIMC publications are loose-leaf, this system of page numbering was recently adopted so that pages from different manuals would not get mixed up. The page number for the objective sheet in Introduction to Electricity, which is unit 2, would look like this:

OBJECTIVE SHEET · **Introduction to Electricity**
CIMC · **A2** · **1**

METHODS OF DISSEMINATING MATERIAL

For best results, provide student materials for each student. Student workbooks contain objective sheets, information sheets, supplements, transparency masters, assignment sheets, and job sheets. Pretest, practical tests, and written tests are packaged separately for students, and can be stored until needed. Students should be allowed to take their materials home at the end of the course.

TEACHING METHODS

Keeping students motivated is a challenge. Supplement the objectives by providing the "why," personal experiences, and current information. If you are going to teach the material in a group setting, prepare for the unit be deciding the best way to teach each objective and allow for student input.

If you are going to follow the plan for individualized instruction, provide opportunities that will allow each student to become involved in planning for and being responsible for his or her own education.

CORRECTIONS AND SUGGESTIONS

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To ensure that the material is updated on a timely basis, notify the CIMC of necessary corrections as soon as possible after discovering the error. Do not assume that someone else will notice the error and inform the CIMC; other users may be making the same assumption. Please send corrections and recommendations for improving this publication to the following address:

Coordinator of Development
Curriculum and Instructional Materials Center
Oklahoma Department of Vocational and
Technical Education
1500 West Seventh Avenue
Stillwater, Oklahoma 74074-4364

For a free catalog, a list of new publications, or other instructional materials information call 1-800-522-5810, extension 589.

RESALE

BASIC SKILLS IN CURRICULUM

The CIMC has always been mindful of the importance of reinforcement (and sometimes remediation) of students' academic skills as they progress through vocational training, and has always included activities in its materials to enhance and promote use of these skills.

Recent state and federal legislation mandates vigorous basic skills development in vocational education in the wake of demands by industry that workers *must* be academically, as well as technically, competent, given the nature of the highly complex work place. In response, the CIMC has taken the following steps to document that, indeed, the instructional materials *do* combine academic skills training with the vocational training. In addition, concerted efforts have been made to "beef up," or enhance the basic skills instruction already present. Following is a brief description of those processes:

Basic Skills Icons and Enablers

To assist teachers and students in identifying activities that promote basic skills development, the CIMC has implemented a marking system that uses simple graphic symbols, or icons, and a list of specific tasks, or enablers, to identify the basic skill or skills that are called for in each job or assignment sheet.

Each of the nine broad skills areas—reading, writing, mathematics, science, oral communication, interpersonal or relating, creative thinking and problem solving, employability, and social studies—is represented by the icon presented below.

Reading

Science

Creative Thinking/ Problem Solving

Writing

Oral Communication

Employability

Math

Interpersonal or Relating

Social Studies

When an activity involving one of these basic skills is identified, the corresponding icon is placed in the left-hand margin of the job or assignment sheet. The basic skills training is further defined by retrieving the specific, or enabling, skill that is required by consulting a list of over two hundred and fifty enablers that has been compiled and grouped with each general basic skill. This enabling skill is placed directly below the icon.

As an example, an exercise that requires a student to conduct library research would make necessary the use of specific reading comprehension and research and reference skills. The basic skills that the exercise promotes would be depicted in the left-hand margin as follows:

ASSIGNMENT SHEET | ***PLANNING LIVING SPACE FOR HUMAN NEEDS*** **1**

Name _____ Score _____

OBJECTIVE 10 **Define personal territory.**

INSTRUCTIONS

Reading Comprehension
- Gain factual information

Functional Reading
- Follow written instructions
- Use content area vocabulary

Language
- Use standard grammar, spelling, and capitalization
- State ideas clearly

- As discussed in Objective 1, each person has an invisible "space bubble" or comfort zone. A comfort zone is the space between oneself and others that brings a feeling of well-being. When one's comfort zone is crowded or invaded, discomfort often results. Therefore, personal territory needs should be a prime consideration when planning living space.
- For each of the following situations, draw your estimated comfort zone around the figures provided.
- Indicate how many inches from your body the comfort zone extends.
- Consider how that comfort zone changes in different situations. Answer the questions that follow.

Basic Skills Documentation Matrix

Another component of the CIMC basic skills instructional plan is the "Basic Skills Documentation Matrix." The matrix graphically summarizes the basic skills training included in the vocational program, unit by unit. It should be helpful to teachers in planning their instruction, and to administrators as documentation that basic skills **are** being addressed during the vocational training.

The matrix for this publication is included as an 8½" by 11" foldout in this *Instructor's Manual.*

Matrices have been developed for most CIMC publications. For more information on those available for other programs, call the CIMC at 1-800-654-4502.

Instructional Supplement

The supplement is a tool for the instructor to use in helping students apply the basic skills in Assignment Sheets and Job Sheets. Some supplements are appropriate for use with all students; some are for use only with those students who do not understand the academic skills called for in the exercise.

MEASURING STUDENT PERFORMANCE GAINS

When you examine this book, you will notice that separate written pretests are no longer included in the units of instruction. Each CIMC unit now contains only a single Written Test. This test should be used as **both** pretest and posttest by giving it once before students start a unit and again when they have completed the unit.

The reason for using a single instrument as both pretest and posttest is so that direct comparison of each student's competencies before and after instruction can be made accurately. This comparison enables precise calculation, documentation, and evaluation of student **performance gains**.

Accurate performance gains analysis is an important requirement of the new Carl Perkins legislation for vocational education. Teachers can make an important contribution to the performance accountability mandated by the new federal legislation by carrying out accurate performance gains analysis for their students, and making this data available to students, parents, and administrators.

This analysis is easy to do and requires only simple calculations and record keeping. Detailed information regarding performance gains analysis is contained in the CIMC publication, *Measuring Learning & Competency Gains: The Pretest/Posttest Approach.* In addition, the CIMC has developed a computer program, CARL, which will perform all necessary calculations and will print out a record form of all information required for gain score analysis. Copies of CARL and the publication are available through your local testing liaison (in Oklahoma), or from the CIMC at 1-800-654-4502.

REQUIRED CRITERIA FOR A COMPETENCY-BASED EDUCATION PROGRAM

Criterion	Discussion	CIMC component meeting criterion
1. Instruction is based on clearly-stated learning objectives that are: a) observable and measurable, and b) communicated in writing to students before instruction begins.	Learning objectives drive CBE. Objectives are the "competencies" that learners must achieve. Each objective must clearly state what *learners* must *do* to demonstrate acquired skill or knowledge. Verbs in learning objectives are active and precise, stating the exact performance expected of learners. The objectives should also specify the standard or level of performance required. Objectives can be at any level of Bloom's Taxonomy and can include the cognitive, psychomotor, and affective domains. Higher-order cognitive skills should be included.	Objective Sheet
2. Instruction is aligned with the stated learning objectives	In CBE, the objectives specify what is taught. "Content" should relate to one or more objectives. The curriculum should cover all objectives with relevant information.	Information Sheet
3. There is a student evaluation system that is: a) criterion-referenced, and b) aligned to the learning objectives and the curriculum.	In CBE, the aim is to bring the performance of *all* learners up to a pre-defined standards and competencies. Learners work on each competency until they achieve "mastery"; the evaluation system should test and record this mastery. Learners can restudy and retest as often as needed. Specific remediation activities should also be available to learners when needed. The evaluation system focuses on what each student has achieved, not on what the instructor has "taught." The "constant" in CBE is student performance; the "variables" are time and resources. (This differs from traditional systems where learners get one chance at mastery; some succeed and some fail. In such systems, time and resources are constant and student achievement is variable.) If an evaluation is criterion-referenced, successful learner performance is defined by (or *referenced* to) mastery of pre-set objectives and standards (or *criteria*): there must be a careful match (or *alignment*) between what the student should master (objectives), what is taught (curriculum), and what is tested. Objectives, curriculum, and evaluation system must all match.	Written Test and Job Sheet/Skill Test

Criterion	Discussion	CIMC component meeting criterion
4. There is an observable management system of cognitive skill practice that provides for, promotes, and documents mastery learning.	For both cognitive and psychomotor skills, a CBE program must have a system of maintaining records of which skills and activities each learner has completed, which ones are in progress, and which ones have not yet been completed. Completion means "mastery"; no skill is completed until the learner has achieved the mastery level. The record system should promote feedback on student skill attainment to *both* instructor and learners, provide for remediation as needed, and encourage reevaluation of learner performance until mastery is achieved. Appropriate remediation strategies often should consider learning styles and other individual differences among learners. Learners should work on skills and activities until they achieve mastery. They should not be "passed on" without mastery. While learners may move ahead and work on other skills (i.e those for which all prerequisite skills have been mastered or those without prerequisites), work should also continue on the skills still requiring mastery. Students should not attempt higher-order skills until all prerequisite skills are mastered.	Assignment Sheet
5. There is an observable management system of psychomotor skill practice that provides for, promotes, and documents mastery learning.		Job Sheet/Skill Test
6. Skill mastery records are maintained for each learner, and learners have access to and make use of these records to monitor their skill acquisition.	Records should clearly indicate the skills each learner has mastered. One such record should profile or list the competencies that have been mastered and those to be mastered. Other performance indicators can be added and kept in a portfolio for each learner. Learners should have ready access to their portfolios to monitor their own progress in skill mastery and competency attainment.	Competency Profile

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This information will be used to correct the publication before the materials are reprinted. To ensure that the material is updated on a timely basis, notify the CIMC of necessary corrections as soon as possible after discovering the error.

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OBJECTIVE SHEET	ELECTRICAL MATERIALS	A 1

INTRODUCTION

This unit will provide you the knowledge to identify the most common materials used in the electrical trade. Materials must be identified and installed properly to meet safety standards required by local and national electrical codes.

PREREQUISITE

Fundamentals of Construction

UNIT OBJECTIVE

After completing this unit, the student will be able to identify and state the purpose of electrical material. The student will demonstrate these competencies by completing the assignment sheets and written test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES

After completing this unit, the student will be able to show the ability to:

1. Given a list of terms associated with electrical materials, match them to their correct definitions.
2. Identify types and sizes of electrical conductors.
3. Match conductor color codes to their names or purposes.
4. Given drawings, select from a list types of conduit, electrical boxes, covers, and plates used in construction. (Assignment Sheet 1)
5. Provided drawings, match the correct titles to electrical hardware such as fasteners, anchors, and connectors. (Assignment Sheet 2)
6. Provided drawings, match the correct titles to electrical receptacles, switches, low voltage components, and sockets. (Assignment Sheet 3)
7. Match drawings to the correct titles for switch enclosures, load centers, and other major electrical components. (Assignment Sheet 4)

SUGGESTED ACTIVITIES	ELECTRICAL MATERIALS A 1
PREPARATION	• Review unit and plan presentation. • Order or obtain materials to supplement unit. • Introduce unit.
DELIVERY	**Objective 1: Given a list of terms associated with electrical materials, match them to their correct definitions.** • Use Information Sheet to discuss terms and definitions associated with electrical materials. • Have students review and discuss the terms and definitions. • Point out the importance of knowing the terms and definitions for common understanding. • Use the National Electrical Code book to supplement your discussion. **Objective 2: Identify types and sizes of electrical conductors.** • Display various sizes of individual conductors and cables. Have students compare the very small conductors against the larger ones, then compare them against the large size cables. **Objective 3: Match conductor color codes to their names or purposes.** • Use the Information Sheets to discuss the cable markings and their uses. • Discuss the significance of color coded insulation.
APPLICATION	**Objective 4: Given drawings, select from a list types of conduit, electrical boxes, covers, and plates used in construction.** (Assignment Sheet 1)

Objective 5: Provided drawings, match the correct titles to hardware such as fasteners, anchors, and connectors. (Assignment Sheet 2)

Objective 6: Provided drawings, match the correct titles to electrical receptacles, switches, low voltage components, and sockets. (Assignment Sheet 3)

Objective 7: Match drawings to the correct titles for switch enclosures, load centers, and other major electrical components. (Assignment Sheet 4)

- Show students examples of electrical materials in product catalogs.
- Allow students to practice identifying electrical material by completing the assignment sheets.

EVALUATION

Pretest

- Give written test as pretest.
- Determine individual study requirements from pretest results.
- Counsel students individually on pretest results and study requirements.
- Modify materials in unit or create supplementary materials for individual students as required.

Skill Test

- Evaluate students on assignment sheet activities.
- Evaluate students on job sheet activities.
- Complete appropriate section of competency profiles.
- Reteach and reevaluate if necessary.
- Modify materials in unit or create supplementary materials for individual students as required.

Written Test

- Explain to students that they will be asked to demonstrate on the written test actions listed in the specific objectives.
- Give the written test.

  NOTE: The written test may be given in sections if desired.
- Complete appropriate sections of competency profiles.
- Reteach and retest if necessary.
- Review individual and group performance in order to evaluate teaching methods. Adjust scope, sequence, or instructional approaches for additional lessons as required.

SUGGESTED RESOURCES

Print Media

- *1993 National Electrical Code,* National Fire Protection Association, Inc., Quincy, MA. 02269.

UNIT REFERENCES

- Colvin, Thomas S. *Electrical Wiring.* American Association for Vocational Instructional Materials, 220 Smithonia Rd., Winterville, GA. 30683.
- Taylor, Mark. *Residential Wiring.* Stillwater, Oklahoma: Mid-America Vocational Curriculum Consortium, Inc., rev. ed. 1983.
- Toenjes, Leonard P. *Building Trades Dictionary.* American Technical Publishers, Inc.: Homewood, IL 60430.

INFORMATION SHEET	ELECTRICAL MATERIALS	A 1

OBJECTIVE 1

Given a list of terms associated with electrical materials, match them to their correct definitions.

- **AC (alternating current)** — the most common type of electricity found in both residential and commercial facilities
- **American Wire Gauge (AWG)** — a standard classification of conductor/wire diameter
- **amperes or amps** — the unit of measure for electrical current—used to specify the load-carrying capacity of cables, fuses, circuit breakers, etc.
- **cable** — the term used to describe the combination of the conductor (wire) and the insulating covering
- **circuit** — complete path for current to flow from the source through the load and back to the source
- **circuit breaker** — switch that automatically interrupts an electric circuit when excessive current passes through it
- **conductor insulation** — the material that surrounds the metal conductor such as rubber or thermoplastic
- **conductor** — material, such as copper and aluminum, which permits the free flow of electricity
- **DC (direct current)** — such as the current provided by batteries
- **device** — electrical equipment that carries or transfers current but does not use it (such as circuit breakers and switches)
- **ground fault circuit interrupters (GFCI)** — special electrical circuits designed to prevent electrical shock to personnel
- **low-voltage system** — wiring system of less than 50 volts originating at a transformer

- **mil** — one thousandth of an inch
- **NEMA** — National Electrical Manufacturer's Association; organization responsible for the setting of specifications for the various classes of enclosures
- **NEMA Type 1** — general-purpose enclosure for indoor use under usual service conditions
- **NEMA Type 3R** — common residential outdoor enclosure

  NOTE: The **R** stands for raintight and signifies that the enclosure will not exclude wind-blown dust.
- **overcurrent protection** — devices that limit the current or amperage through an electrical circuit; fuses and circuit breakers are examples of overcurrent protection devices.
- **receptacle** — mounted, female electrical fitting that contains the live parts of the circuit
- **relay** — a control device used to electrically route a current path
- **stranded wire** — conductor made up of a number of smaller conductors twisted together; standard wire is required where vibration might cause wire breakage
- **surface raceways** — a conduit system designed for surface installations
- **surge protector** — electronic circuits that protect sensitive electrical equipment from momentary increases of the AC input voltage
- **switch** — device used to open/close or alter an electrical path
- **transformer** — electrical device used to step up or step down a primary voltage to a desired secondary voltage
- **type letter** — identification accepted by the trade in referring to a particular type of conductor insulation

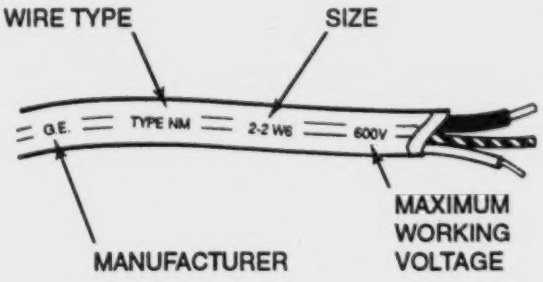
- **underwriters laboratory (UL)** — an organization that tests electrical products to determine if they meet minimum standards for safety and quality
- **voltage** — unit of measure for volts—electrical difference between two points

OBJECTIVE 2

Identify types and sizes of electrical conductors.

- Cable type identification codes

FIGURE 1



- Wire type
  - — NM or nonmetallic cable — used primarily indoors as branch circuits
  - — TW — often used as the main electrical input and can be in larger sizes with heavy insulation
  - — low-voltage cable — smaller cables used in applications below 50 volts
  - — UF — underground cable covered with moisture resistant insulation
  - — USE — underground cable used as service-entrance

- Maximum working voltage — highest voltage that the cable can safely carry

  NOTE: Cable must be used within their voltage, amperage, and insulation ratings to meet electrical codes.

- Size classification of conductors

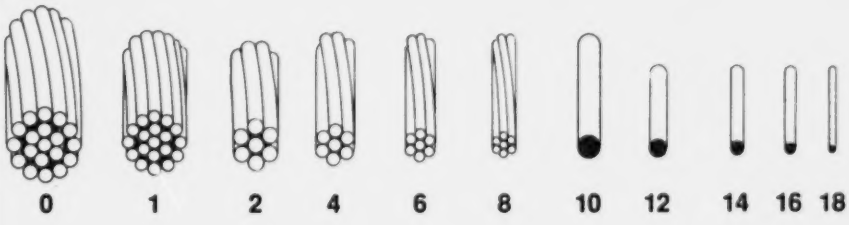
  — American wire gauge (AWG)

  A. AWG is a standard size classification in the United States for copper and aluminum wires used in electrical construction

  B. AWG sizes extends from 18 gauge to 0 gauge

  EXAMPLE:

FIGURE 2 Size of conductors



Actual diameters of typical sizes of electric wires without insulation

- Conductor material types

  — Copper

  — Aluminum

  — Aluminum with coating of copper

  NOTE: Some local building codes may restrict the use of aluminum wiring; check your building plans.

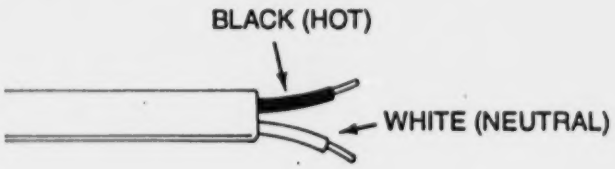
OBJECTIVE 3

Given a description of cable identification markings, choose their correct use.

- Wire colors codes

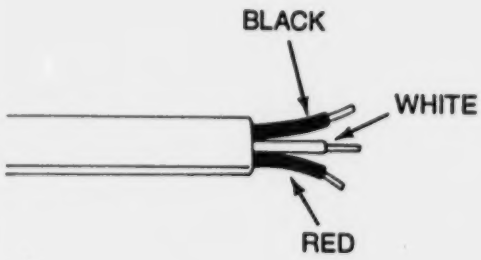
  — Two wire cable (without ground wire)

FIGURE 3



  — Three wire cable (without ground wire)

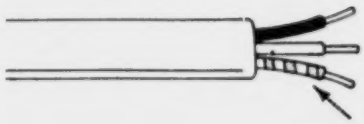
FIGURE 4



  — Two wire cable (with ground wire)

FIGURE 5

FIGURE 6

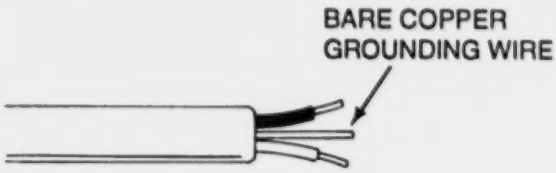


GROUNDING WIRE
(GREEN WITH YELLOW STRIPES)

NOTE: Cables which have a conductor with green or green with yellow striped insulation shall use that conductor for grounding purposes only.

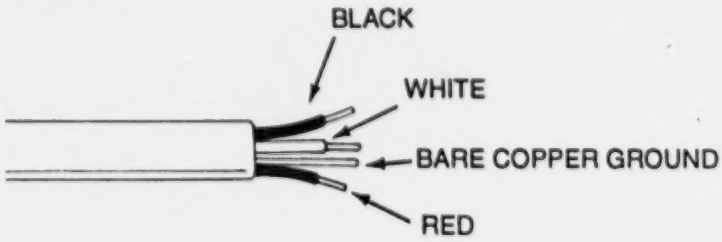
— Two wire cable (non-metallic sheathing)

FIGURE 7



— Three wire cable (non-metallic sheathing)

FIGURE 8



NOTE: Non-metallic sheathed cable is often referred to by its trade name "ROMEX." Other vendors of non-metallic sheathing are available.

OBJECTIVE 4

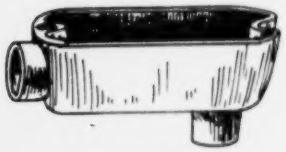
Given drawings, select from a list types of conduit, electrical boxes, covers, and plates used in construction. (Assignment Sheet 1)

- Rigid metal conduit system

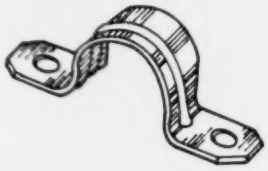
FIGURE 9

Metal Conduit and Coupling

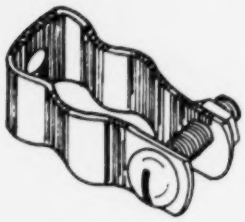
One-Hole Strap



Conduit Body



Two-Hole Strap



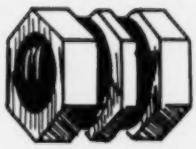
Pipe Hanger

- Electrical metallic tubing system (EMT)

FIGURE 10

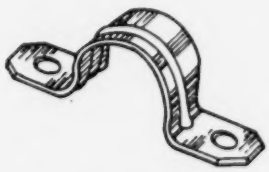
Electrical Metallic Conduit

One-Hole Strap

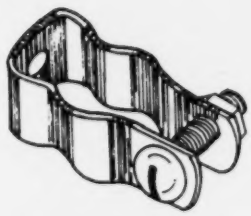


EMT Coupling

EMT Connector



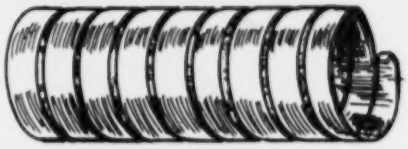
Two-Hole Strap



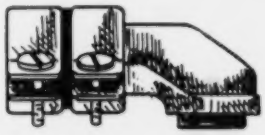
Pipe Hanger

- Flexible metal conduit system

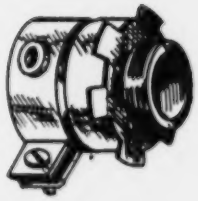
FIGURE 11



Flexible Metal Conduit



90° Connector

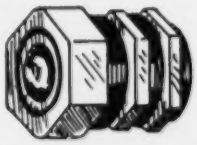


Straight Connector

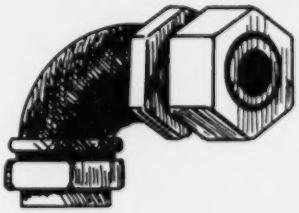
- Liquid tight flexible metal conduit system

FIGURE 12

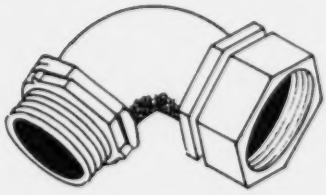
Liquid Tight Flexible Metal Conduit



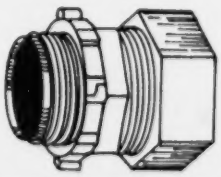
Straight Connector



90° Connector



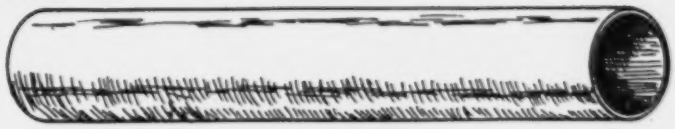
90° Compression Connector
(Rain Tight)



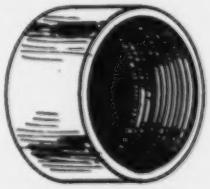
Compression Connector
(Rain Tight)

- Polyvinyl chloride conduit system (PVC)

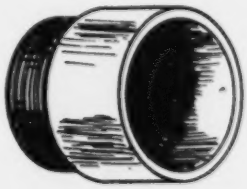
FIGURE 13



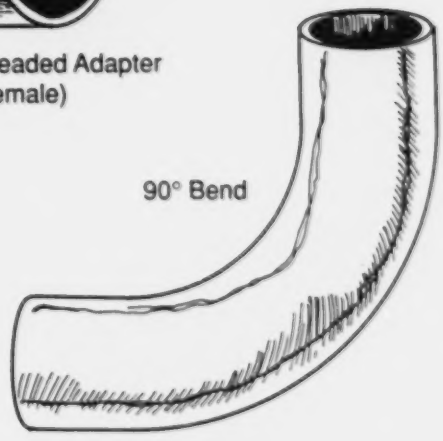
PVC Conduit



PVC to Threaded Adapter
(Female)



PVC to Threaded Adapter
(Male)

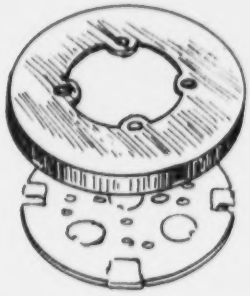


90° Bend

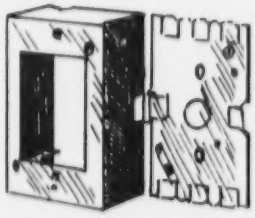
NOTE: Joining PVC requires the use of a cement sealant. Be sure to consult the MSDS sheet for proper handling.

- Surface raceway system

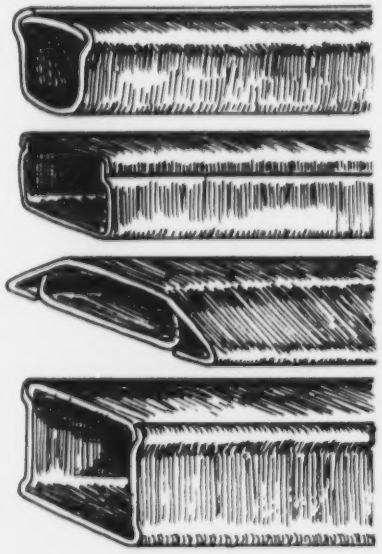
FIGURE 14



Surface Lighting Outlet



Surface Device Box



Surface Raceways

- Boxes used in construction wiring

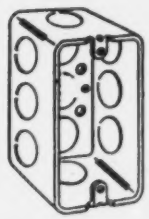
  — Device boxes

  NOTE: Most boxes can be purchased in either metal or non-metallic composition (fiber, plastic, nylon, or rubber).

  A. Handy boxes

  a. Molded plastic

FIGURE 15

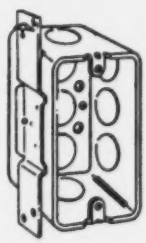


b. Welded metal

FIGURE 16

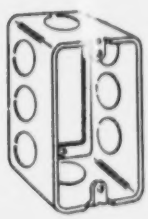
c. Bracket box

FIGURE 17



d. Extension

FIGURE 18



NOTE: Extensions allow the box to protrude out to the edge of the wall/ceiling covering material (such as paneling or drywall). Extensions can be purchased for all types of boxes.

B. Octagon boxes

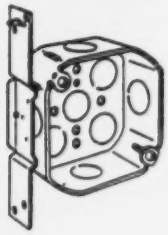
NOTE: Octagon boxes, like switch boxes, can be either metallic or non-metallic. They can be purchased in many different depths.

a. With cable clamps and nail holes

FIGURE 19

b. With bracket

FIGURE 20



c. Extension

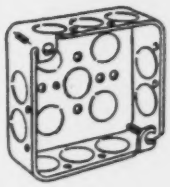
FIGURE 21

C. Square boxes

NOTE: Square boxes are usually used in conjunction with covers designed for special purposes.

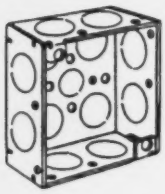
a. Molded plastic

FIGURE 22



b. Welded metal

FIGURE 23



— Covers and plates

A. Flat blank

FIGURE 24

B. Flat toggle

FIGURE 25

C. Flat duplex

FIGURE 26

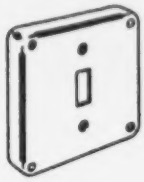
D. Square flat blank

FIGURE 27

— Exposed work raised square covers

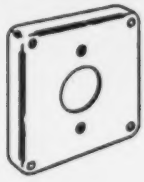
A. Single toggle switch

FIGURE 28



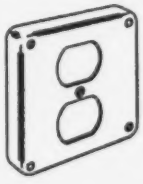
B. Single receptacle

FIGURE 29



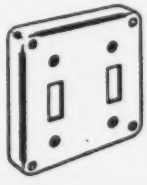
C. Duplex receptacle

FIGURE 30



D. Two toggle switches

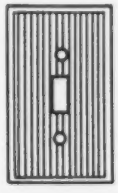
FIGURE 31



— Wall plates

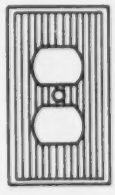
A. Single toggle switch

FIGURE 32



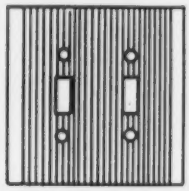
B. Duplex receptacle

FIGURE 33



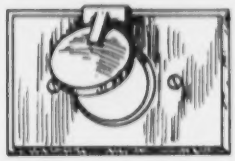
C. Two toggle switches

FIGURE 34



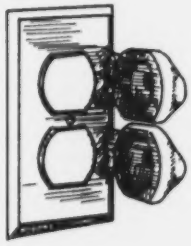
D. Weatherproof single receptacle

FIGURE 35



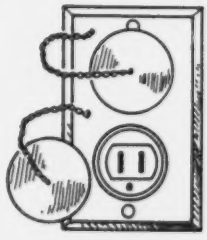
E. Weatherproof duplex receptacle (horizontal)

FIGURE 36



F. Weatherproof duplex receptacle with screw covers

FIGURE 37



OBJECTIVE 5

Provided drawings, match the correct titles to electrical hardware such as fasteners, anchors, and connectors. (Assignment Sheet 2)

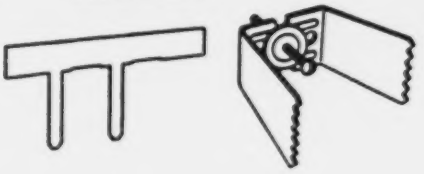
- Common supports and anchors

A. Bar hanger

FIGURE 38

B. Switch box supports

FIGURE 39



C. One hole strap

FIGURE 40

D. Two hole strap

FIGURE 41

E. Plastic anchors

FIGURE 42

Flange Plug

F. Expansion bolt

FIGURE 43

G. Toggle bolt

FIGURE 44

H. Molley bolt anchor

FIGURE 45

I. Drive pin

FIGURE 46

J. Drive stud

FIGURE 47

NOTE: Drive pins and studs are commonly driven using a powder activated tool.

FIGURE 48

K. Sheet metal screw

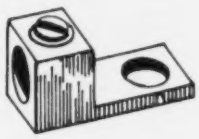
FIGURE 49

L. Self-drilling screw

- Common connectors, terminals, and lugs
  - — Connectors

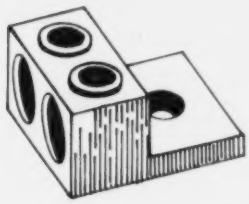
A. Solderless lug

FIGURE 50



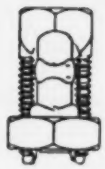
B. Solderless lug (twin)

FIGURE 51



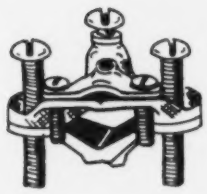
C. Split bolt

FIGURE 52



D. Ground clamp

FIGURE 53

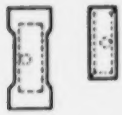


E. Wire nuts

FIGURE 54

F. Crimp-type butt connectors

FIGURE 55



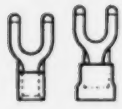
— Terminals

A. Ring

FIGURE 56

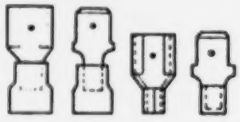
B. Spade

FIGURE 57



C. Quick disconnect

FIGURE 58



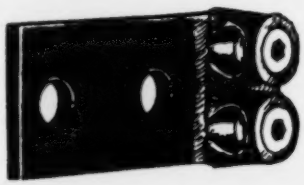
— Lugs

A. Single terminal lug

FIGURE 59

B. Twin terminal lug

FIGURE 60



OBJECTIVE 6

Provided drawings, match the correct title to electrical receptacles, switches, low voltage components, and sockets. (Assignment Sheet 3)

- Devices commonly used in construction wiring

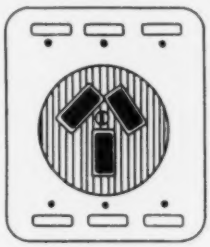
  NOTE: Manufacturers make different grades of devices. Price and quality vary with the grades. Specification grade is the most expensive. Before installing devices, check the grade specified in the building plans.

— Receptacles

A. Range

125/250V; 50 amp

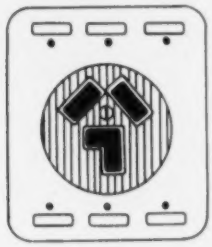
FIGURE 61



B. Dryer

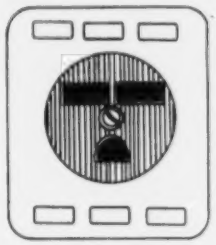
125/250V; 30 amp

FIGURE 62



C. Air conditioning
250V; 30 amp

FIGURE 63



D. Air conditioning
250V; 20 amp

FIGURE 64

E. Duplex grounding
125V; 15 amp

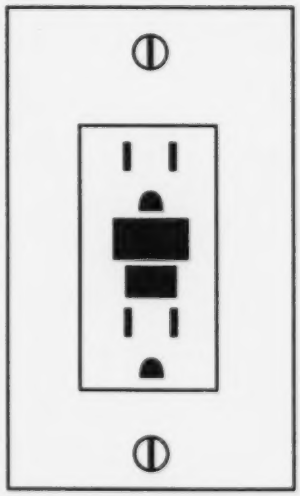
FIGURE 65

F. Dual voltage
125/250V; 20 amp

FIGURE 66

G. GFCI receptacles

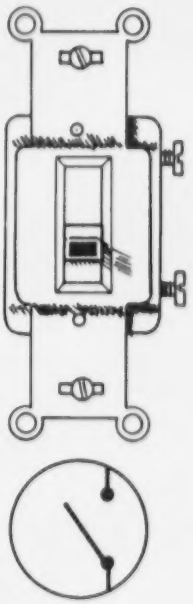
FIGURE 67



— Switches

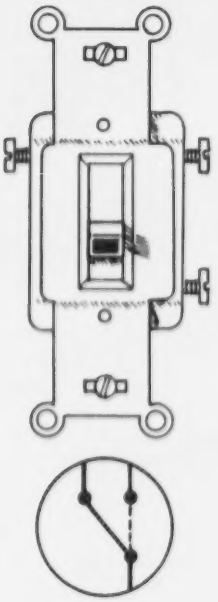
A. Single pole

FIGURE 68



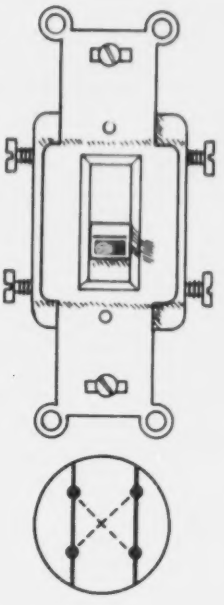
B. Three way

FIGURE 69



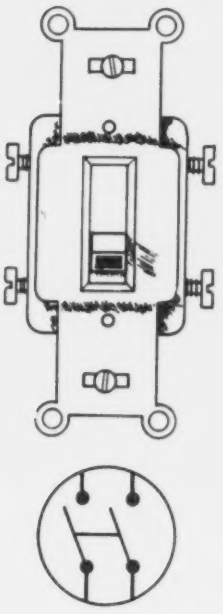
C. Four way

FIGURE 70



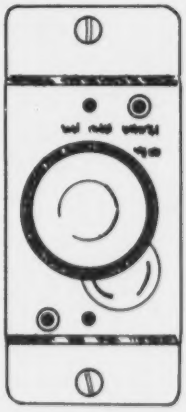
D. Double pole

FIGURE 71



E. Dimmer

FIGURE 72



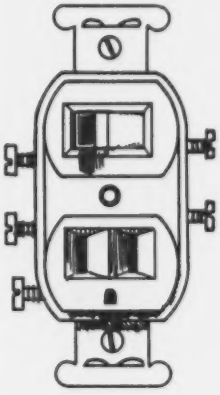
F. Low voltage push button

FIGURE 73

— Combination devices

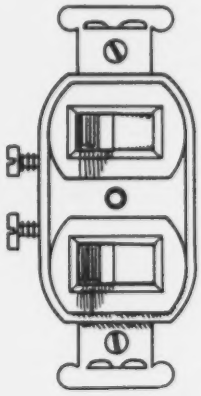
A. Switch and receptacle

FIGURE 74



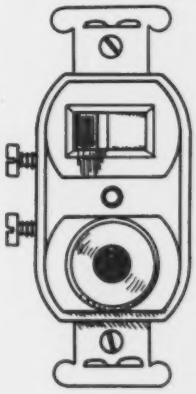
B. Two switches

FIGURE 75



C. Switch and pilot light

FIGURE 76



— Low voltage components

FIGURE 77

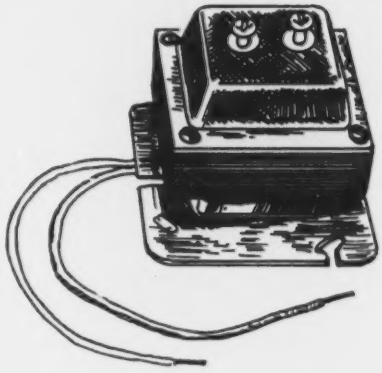
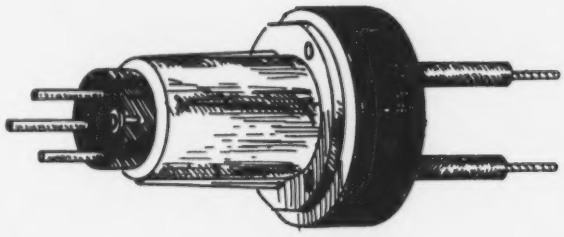


FIGURE 78

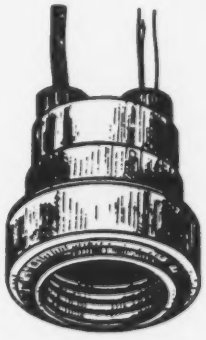


NOTE: There are many types and shapes of low voltage relays used in electrical systems.

— Sockets

A. Keyless pigtail

FIGURE 79

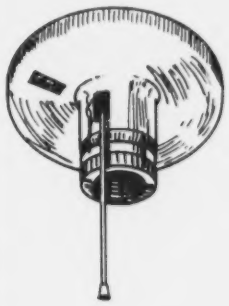


B. Keyless cover

FIGURE 80

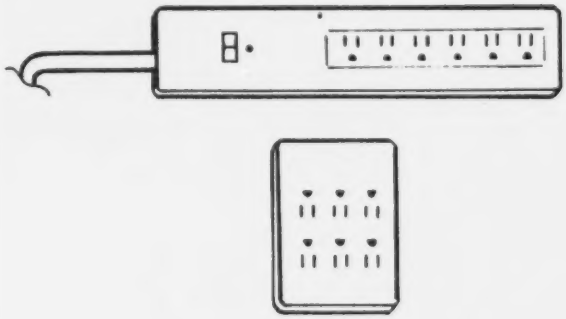
C. Pull chain cover

FIGURE 81



— Surge protectors

FIGURE 82



OBJECTIVE 7

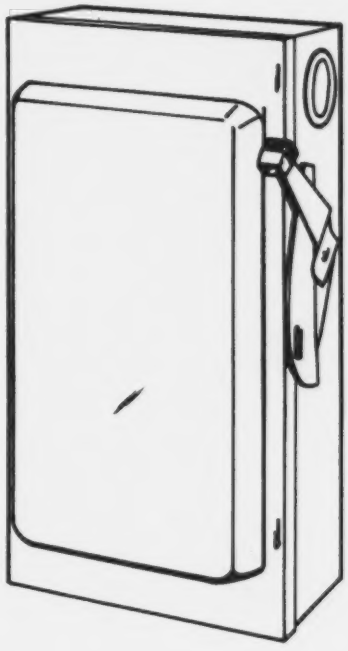
Match drawings to the correct titles for switch enclosures, load centers, and other major electrical components. (Assignment Sheet 4)

- Types of safety switch enclosures

  NOTE: This can be either a general duty or a heavy duty rated switch. Switch enclosures come in fused and non-fused versions.

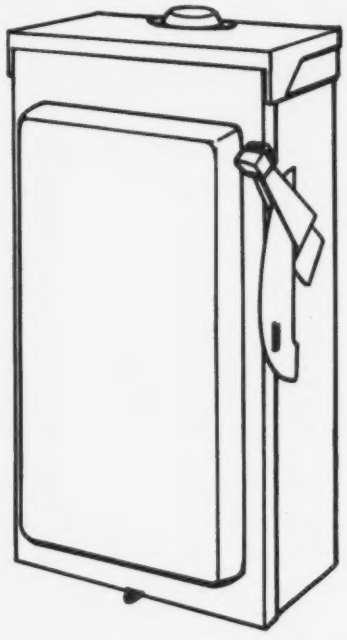
  — Indoor switch enclosure (NEMA Type 1)

FIGURE 83



— Raintight switch enclosure (NEMA Type 3R)

FIGURE 84



NOTE: These switches can be fusible or nonfusible, depending on need. Either type will serve as the disconnect for an air conditioning system condenser. Always refer to local code and appliance manufacturer's instructions when installing switch enclosures.

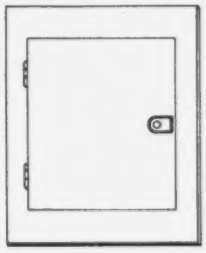
- Load centers

  — Methods of installation

  NOTE: These are possible methods for the installation of load centers for both new construction and remodel work. A new exterior mounted center is often used to feed an existing center as a sub-center to provide more circuits in a remodel.

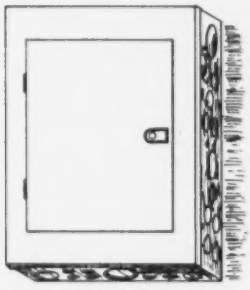
A. Flush interior

FIGURE 85



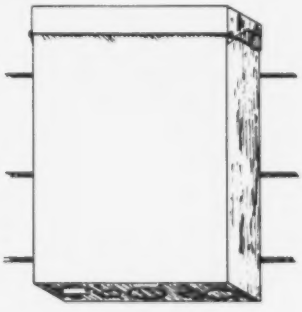
B. Surface interior

FIGURE 86



C. Surface exterior

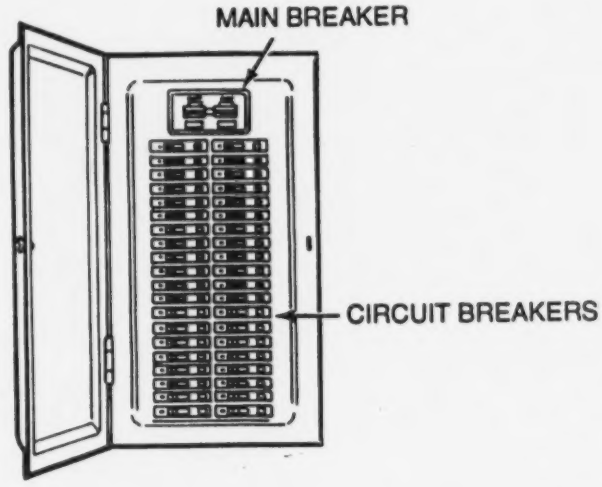
FIGURE 87



NOTE: Load centers may be called breaker boxes, service entrance panels, or main breaker panels.

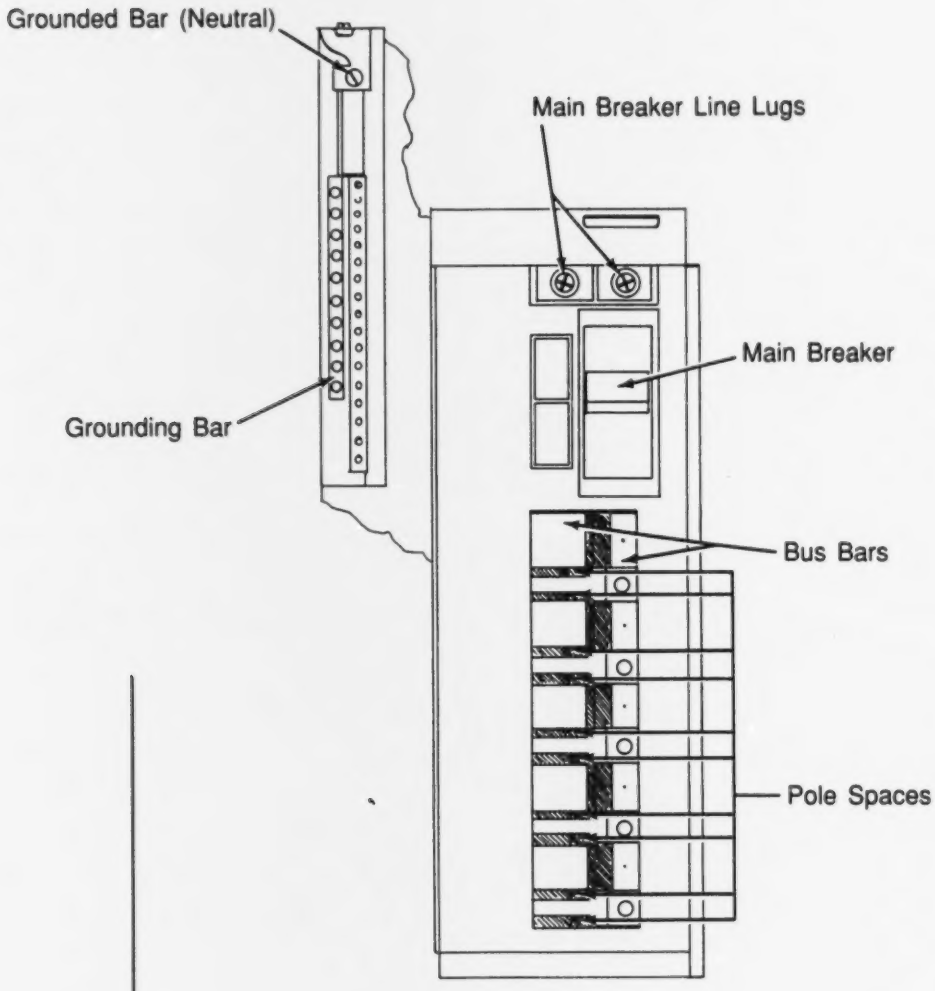
— Load center with circuit breakers

FIGURE 88



— Parts of a breaker load center

FIGURE 89



— Common load center accessories

A. Grounding or grounded bar

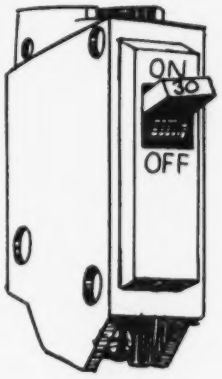
FIGURE 90

B. Lug

FIGURE 91

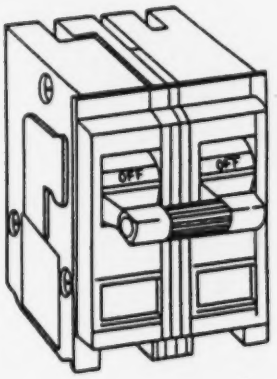
C. Single pole circuit breaker

FIGURE 92



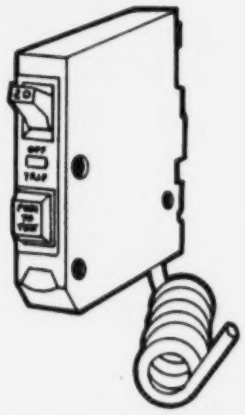
D. Double pole circuit breaker

FIGURE 93



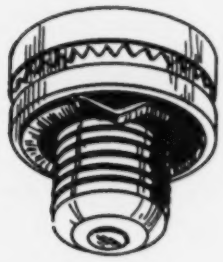
E. GFCI circuit breaker

FIGURE 94



F. Plug fuse

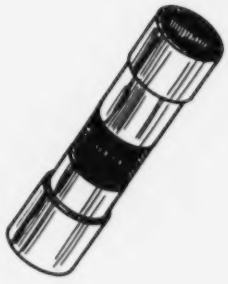
FIGURE 95



NOTE: National and local electrical codes specify the type and size of circuit breakers required in each application.

G. Cartridge fuse

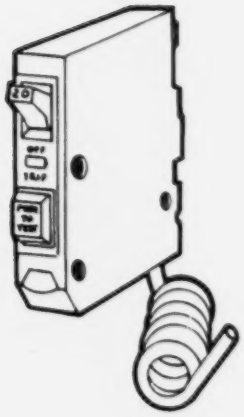
FIGURE 96



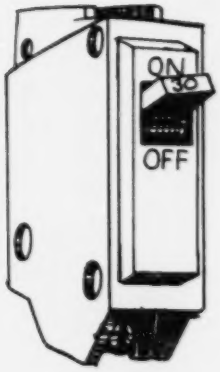
H. Blade type cartridge fuse

FIGURE 97

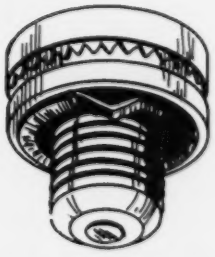
Overcurrent Protection Devices



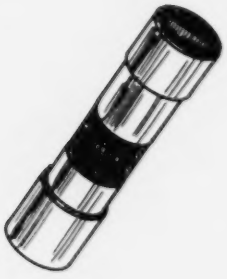
GFCI circuit breaker



Single pole circuit breaker



Type "S" plug fuse



Cartridge fuse

ASSIGNMENT SHEET 1	ELECTRICAL MATERIALS	A 1

Name _____ Score _____

OBJECTIVE 4

Given drawings, select from a list types of conduit, electrical boxes, covers, and plates used in construction.

INTRODUCTION

This exercise allows you to practice the identification of conduit, electrical boxes, covers, and plates.

INSTRUCTIONS

Select the correct title of each drawing and write it below the corresponding drawing.

Functional Reading
- Use content area vocabulary

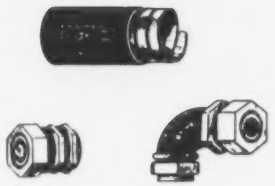
Part A — Conduit systems

Flexible metal conduit system
Surface raceway system
Liquid tight flexible metal conduit system
Electrical metallic tubing system
Polyvinyl chloride conduit system (PVC)
Rigid metal conduit system

1. _____ 2. _____

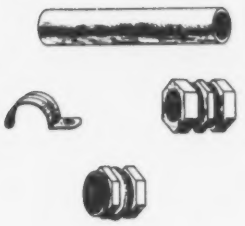
_____ _____

votech



3. _____

_____



4. _____

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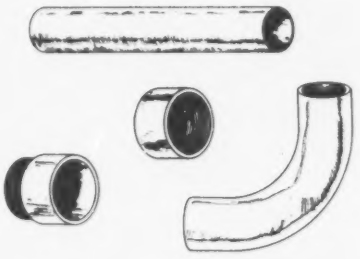

5. _____

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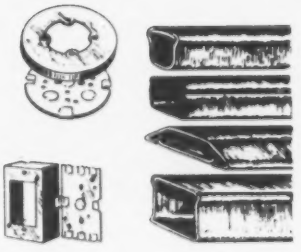
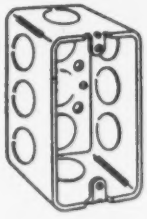


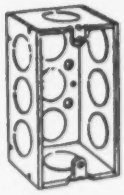
6. _____

_____

Part B — Boxes

Handy box — bracket
Square box — molded plastic
Handy box — welded metal
Octagon with cable clamps and nail holes
Handy box — molded plastic
Handy box — extension



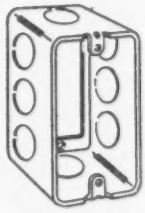


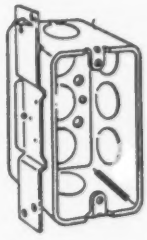
1. _____

_____

2. _____

_____





3. _____

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4. _____

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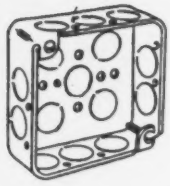


5. _____ 6. _____

_____ _____

Part C — Covers and plates

Weatherproof duplex receptacle
Flat duplex
Single toggle switch (raised)

Flat blank
Flat toggle
Square flat blank
Single toggle switch
Duplex receptacle

1. _____ 2. _____

_____ _____

3. _____

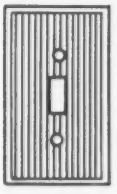
_____

4. _____

_____

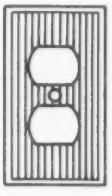
5. _____

_____



6. _____

_____



7. _____

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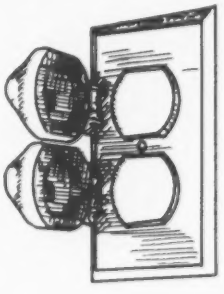


8. _____

_____

ASSIGNMENT SHEET 2	ELECTRICAL MATERIALS	A 1

Name _____ Score _____

OBJECTIVE 5

Provided drawings, match the correct titles to electrical hardware such as fasteners, anchors, and connectors.

INTRODUCTION

Use this exercise to practice the identification of hardware such as fasteners, anchors, and connectors.

INSTRUCTIONS

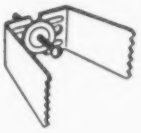
Match the correct title to each drawing in the space provided.

Functional Reading
- Use content area vocabulary

General Science
- Investigate/apply technology

Part A — Supports and anchors

Bar hanger
Toggle bolt
One hole strap
Two hole strap
Drive stud
Switch box supports
Plastic anchors
Drive pin
Expansion bolt
Molley bolt anchor

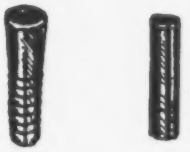


1. _____ 2. _____

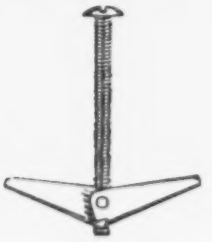
votech

3. _____

4. _____

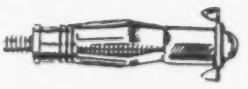


5. _____



6. _____

7. _____



8. _____

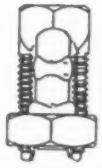
9. _____

10. _____

Part B — Connectors, terminals, and lugs

Connectors	Terminals	Lugs
Crimp-type butt connector	Quick disconnect	Single terminal lug
Service entrance	Ring terminal	Twin terminal lug
Wire nuts	Spade terminal	
Crimp sleeve	Spade terminal	
Set screw		
Split bolt		

1. _____ 2. _____



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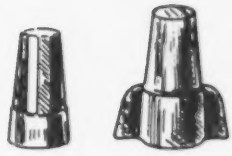
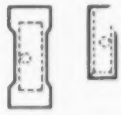
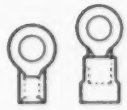
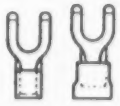


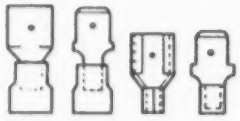
4. _____ 5. _____





6. _____ 7. _____





8. _____ 9. _____

votech

10. _____ 11. _____

ASSIGNMENT SHEET 3	ELECTRICAL MATERIALS	A 1

Name _____ Score _____

OBJECTIVE 6

Provided drawings, match the correct titles to electrical receptacles, switches, low voltage components, and sockets.

INTRODUCTION

Practice the identification of common material used in electrical construction by completing this exercise.

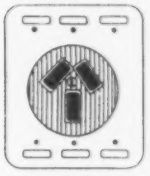
INSTRUCTIONS

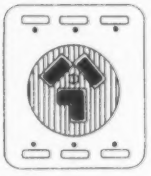
Match the drawing to the correct title by writing the title in the space provided.

Functional Reading
- Interpret graphics and symbols
- Use content area vocabulary

Part A — Receptacles

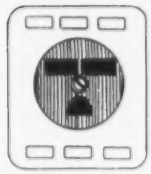
Range receptacle 125/250V; 50 amp
Dryer receptacle 125/250V; 30 amp
Air conditioning receptacle 250V; 30 amp
Air conditioning receptacle 250V; 20 amp
Duplex grounding receptacle 125V; 15 amp
Dual voltage receptacle 125/250V; 20 amp





1. _____ 2. _____

votech



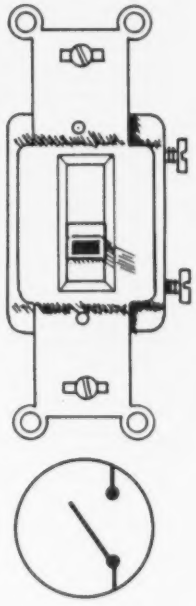
3. _____ 4. _____

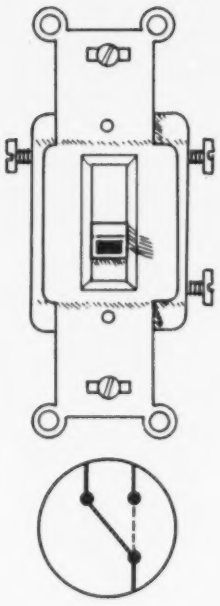
5. _____ 6. _____

votech

Part B — Switches

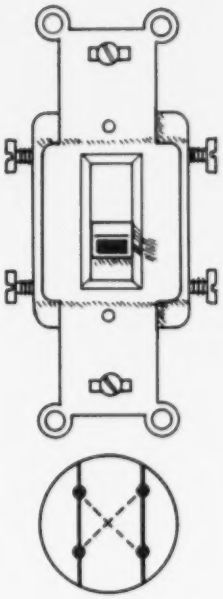
Single pole
Three way
Four way





1. _____ 2. _____

votech



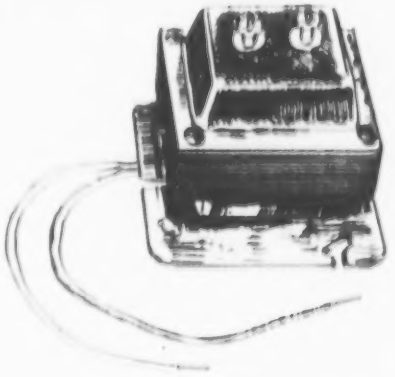
3. _____

Part C — Low voltage components and sockets

Low voltage transformer
Keyless cover
Pull chain cover

1

2



3

ASSIGNMENT SHEET 4	ELECTRICAL MATERIALS	A 1

Name _____ Score _____

OBJECTIVE 7

Match drawings to the correct titles for switch enclosures, load centers, and other major electrical components.

INTRODUCTION

Switches are used to disconnect major electrical units, such as air conditioners, from AC power. Load centers are used to distribute the incoming AC to branch circuits throughout a facility.

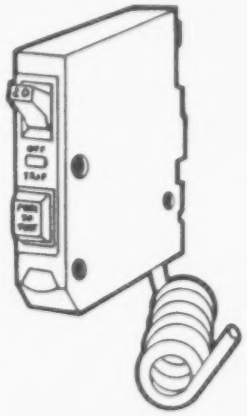
INSTRUCTIONS

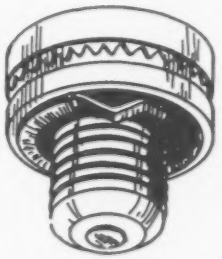
Match each drawing to the correct title by writing in the space provided.

Functional Reading
- Use content area vocabulary

General Science
- Collect specimens

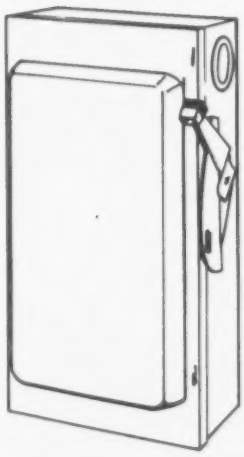
Indoor switch enclosure
Load center with circuit breakers
GFCI circuit breaker
Plug fuse
Grounding bar
Single pole circuit breaker



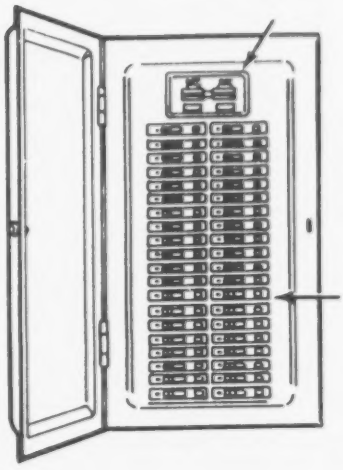


1. _____ 2. _____

votech

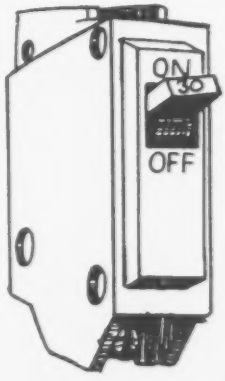


3. _____



4. _____

5. _____



6. _____

ASSIGNMENT SHEET 1

Part A — Conduit systems

1. Rigid metal conduit system
2. Flexible metal conduit system
3. Liquid-tight flexible metal conduit system
4. Electrical metallic tubing system
5. Polyvinyl chloride (PVC) conduit system
6. Surface raceway system

Part B — Boxes

1. Handy box — molded plastic
2. Handy box — welded metal
3. Handy box — extension
4. Handy box — bracket
5. Octagon with cable clamps and nail holes
6. Square box — molded plastic

Part C — Covers and plates

1. Flat blank
2. Flat toggle
3. Flat duplex
4. Square flat blank
5. Single toggle switch (raised)
6. Single toggle switch
7. Duplex receptacle
8. Weatherproof duplex receptacle

ASSIGNMENT SHEET 2

Part A — Supports and anchors

1. Bar hanger
2. Switch box supports
3. One hole strap
4. Two hole strap
5. Plastic anchors
6. Toggle bolt

7. Drive pin
8. Molley bolt anchor
9. Drive stud
10. Expansion bolt

Part B — Connectors, terminals, and lugs

1. Crimp sleeve
2. Set screw
3. Split bolt
4. Service entrance
5. Wire nuts
6. Crimp-type butt connector
7. Ring terminal
8. Spade terminal
9. Quick disconnect
10. Twin terminal lug
11. Single terminal lug

ASSIGNMENT SHEET 3

Part A — Receptacles

1. Range receptacle
2. Dryer receptacle
3. Air conditioning
4. Air conditioning
5. Duplex grounding
6. Dual voltage

Part B — Switches

1. Single pole
2. Three way
3. Four way

Part C — Low voltage components and sockets

1. Keyless cover
2. Pull chain cover
3. Low voltage transformer

ASSIGNMENT SHEET 4

1. GFCI circuit breaker
2. Plug fuse
3. Indoor switch enclosure
4. Load center with circuit breakers
5. Grounding bar
6. Single pole circuit breaker

WRITTEN TEST	ELECTRICAL MATERIALS	A 1

Name _____ Score _____

OBJECTIVE 1

Given a list of terms associated with electrical materials, match them to their correct definitions. Write the letter that corresponds to the most correct answer.

_____ 1. Material which permits the free flow of electricity such as copper and aluminum is a/an

a. conductor
b. insulator
c. transmitter
d. carrier

_____ 2. A device used to open or close an electrical path is a/an

a. switch
b. conductor
c. receptacle
d. enclosure

_____ 3. The material that surrounds the metal conductor such as rubber or thermoplastic is

a. conductor path
b. surge protection
c. wrap covering
d. conductor insulation

_____ 4. A standard classification of conductor/wire diameter is

a. ARG
b. American Wire Gauge
c. United Wire Association
d. Standard Diameter Organization (SDO)

May be photocopied for student use.

_____ 5. Special electrical circuits designed to prevent electrical shock to personnel are

a. GFCI
b. AWG
c. AMP
d. Surge protectors

_____ 6. Electronic circuits that protect sensitive electrical equipment from momentary increases of the AC input voltage are

a. circuit breakers
b. fuses
c. surge protectors
d. overcurrent protection devices

_____ 7. The complete path for current to flow from source through the load and back to the source is a

a. raceway
b. pathway
c. circuit
d. transformer

_____ 8. A wiring system of less than 50 volts originating at a transformer can be described as

a. low-current system
b. transformed system
c. trickle voltage system
d. low-voltage system

_____ 9. Mounted, female electrical fittings that contain the live parts of the circuit are known as

a. transformers
b. circuit breaker
c. receptacles
d. cables

May be photocopied for student use.

_____10. The term used to describe the combination of the conductor (wire) and the insulating cover is a/an

a. conductor
b. cable
c. AWG standard
d. branch

_____11. A common residential outdoor enclosure can be rated as a/an

a. NEMA Type 3R
b. NEMA Type 1
c. AWG Type ⊖ T
d. NW Type ⊖ R

_____12. Devices that limit the current or amperage through an electrical circuit are called

a. voltage protectors
b. overcurrent protection
c. voltage limiters
d. switches

_____13. Electrical devices used to step up or step down a primary voltage to a desired secondary voltage are called

a. receptacles
b. circuit breakers
c. voltage doublers
d. transformers

_____14. A switch that automatically interrupts an electric circuit when excessive current passes through it is a/an

a. transformer
b. interrupter
c. surge protector
d. circuit breaker

May be photocopied for student use.

_____15. One thousandth of an inch is a/an

a. decibel
b. AWG
c. mil
d. circular mil

_____16. A conduit system designed for surface installations is called

a. surface mounted pipe
b. overhead rigid tubing
c. flex-metal conduits
d. surface raceways

_____17. Identification accepted by the trade in referring to a particular type of conductor insulation is called the

a. type letter
b. insulation code
c. conductor type
d. AWG color code

OBJECTIVE 2

Identify types and sizes of electrical conductors.

_____ 1. A conductor insulation that has a type letter of "TW" is

a. made of thermo-blend and webbed fabric
b. made of aluminum and covered with thermoplastic
c. made of thermoplastic and is moisture resistant
d. made of polymer and is covered in nylon

_____ 2. Electrical conductors are commonly made of

a. rubber, nylon, and thermoplastic
b. copper, aluminum, and copper-coated aluminum
c. steel, iron, copper, and aluminum
d. copper, aluminum, and aluminum-coated copper

May be photocopied for student use.

_____ 3. Which of the following wire sizes is largest?

a. 0003 gauge
b. 0002 gauge
c. 0001 gauge
d. 0000 gauge

_____ 4. Which of the following AWG sizes represents the *smallest* wire diameter?

a. 18
b. 16
c. 14
d. 12

_____ 5. A type of cable used primarily indoors as branch circuits is known as

a. NM — nonmetallic sheathed cable
b. NM — low-voltage cable
c. BC — branch circuit rated
d. UF — indoor cable

_____ 6. What type of cable is often used as the main electrical input and is larger in size and heavily insulated?

a. NM — service entrance cable
b. HV — heavy cable
c. MW — massive wire
d. TW — service entrance cable

OBJECTIVE 3 **Match conductor color codes to their names or purposes.**

_____ 1. The standard wire color codes for a two wire cable without a ground wire is

a. red and white
b. green and red
c. black and white
d. both a and b are correct

May be photocopied for student use.

_____ 2. All electrical cables that have a bare copper wire use it for

a. grounding only
b. return conductor
c. neutral wire
d. hot wire

_____ 3. Cables with green or green with yellow striped conductors use it as

a. neutral wire
b. hot wire
c. return wire
d. grounding only

_____ 4. The black insulated conductor is often called the

a. return wire
b. ground wire
c. neutral wire
d. hot wire

_____ 5. The white insulated conductor is referred to as the

a. return wire
b. neutral wire
c. ground wire
d. hot wire

OBJECTIVES 4-7

Evaluated through the completion of Assignment Sheets.

May be photocopied for student use.

WRITTEN TEST ANSWERS	ELECTRICAL MATERIALS	A 1

OBJECTIVE 1

1. a
2. a
3. d
4. b
5. a
6. c
7. c
8. d
9. c
10. b
11. a
12. b
13. d
14. d
15. c
16. d
17. a

OBJECTIVE 2

1. c
2. b
3. d
4. a
5. a
6. d

OBJECTIVE 3

1. c
2. a
3. d
4. d
5. b

OBJECTIVES 4-7

Evaluated through the completion of Assignment Sheets.

CIMC
TEST CODE SHEET

VOCATIONAL PROGRAM (BOOK TITLE) INTRODUCTION TO ELECTRICITY

UNIT NUMBER AND TITLE – A1 – ELECTRICAL MATERIALS

TOTAL NUMBER OF TEST QUESTIONS 28

TOTAL NUMBER OF BASIC SKILL QUESTIONS 14

OBJECTIVE NUMBER	TEST QUESTION NUMBER(S)	BASIC SKILL CODE(S)
1	1-3, 6-10, 12-14	S
1	4, 5, 11, 16, 17	X
1	15	M
2	1, 2	S
2	3-6	X
3	1-5	X
4-7	Evaluated on Assignment Sheets	

OBJECTIVE SHEET	ELECTRICAL TOOLS A 2
INTRODUCTION	This unit provides information on the identification and safe use of tools commonly used by electricians and their helpers. Personnel safety is a very real concern for electricians, and this lesson provides you with many safety guidelines.
PREREQUISITE	*Fundamentals of Construction*
UNIT OBJECTIVE	After completing this unit, the student will be able to identify and safely use basic electrical tools. The student will demonstrate these competencies by completing job sheets and written test with a minimum of 85 percent accuracy.
SPECIFIC OBJECTIVES	After completing this unit, the student will be able to show the ability to: 1. Given a list of terms associated with electrical tools, match them to their correct definitions. 2. Complete statements concerning the safe use and care of electrical tools. 3. Given drawings, match them to the titles of electrical tools. 4. Adjust wire strippers. (Job Sheet 1) 5. Trim conductor insulation using a knife. (Job Sheet 2) 6. Use a soldering gun to splice conductors. (Job Sheet 3) 7. Cut and ream rigid conduit. (Job Sheet 4) 8. Use a volt ohmmeter. (Job Sheet 5)

SUGGESTED ACTIVITIES	ELECTRICAL TOOLS A 2
PREPARATION	• Review unit and plan presentation. • Order or obtain materials to supplement unit. • Introduce unit.
DELIVERY	**Objective 1: Given a list of terms associated with electrical tools, match them to their correct definitions.** • Use Information Sheet to discuss terms and definitions. • Display samples of terms when appropriate to reinforce discussion. • Discuss or demonstrate terms that are unfamiliar to students. **Objective 2: Complete statements concerning the safe use and care of electrical tools.** • Explain how good care and maintenance will preserve tools so that they will last for many years. • Discuss how safe and proper use of tools will save tools and prevent accidents, some that could be fatal. • Have students explain details of accidents that happened when tools were used improperly. • Demonstrate how to clean and store tools properly. • Stress that testing instruments are expensive, precision instruments that must be handled very carefully. **Objective 3: Given drawings, match them to the titles of electrical tools.** • Obtain several tool catalogs to display for students to review.

- Show tools that are available in your shop or lab.
- Emphasize the dangers of using tools on live or hot circuits and to avoid this whenever possible.
- Identify tools you recommend be carried in a tool pouch.

APPLICATION

Objective 4: Adjust wire strippers. (Job Sheet 1)

Objective 5: Trim conductor insulation using a knife. (Job Sheet 2)

Objective 6: Use a soldering gun to splice conductors. (Job Sheet 3)

Objective 7: Cut and ream rigid conduit. (Job Sheet 4)

Objective 8: Use a volt ohmmeter. (Job Sheet 5)

- Assign students to complete job sheets. Supervise performance of Job Sheet 5 to ensure student safety.

EVALUATION

Pretest

- Give written test as pretest.
- Determine individual study requirements from pretest results.
- Counsel students individually on pretest results and study requirements.
- Modify materials in unit or create supplementary materials for individual students as required.

Skill Test

- Evaluate students on job sheet activities.
- Complete appropriate section of competency profiles.
- Reteach and reevaluate if necessary.

- Modify materials in unit or create supplementary materials for individual students as required.

Written Test

- Explain to students that they will be asked to demonstrate on the written test actions listed in the specific objectives.
- Give the written test.

  NOTE: The written test may be given in sections if desired.
- Complete appropriate sections of competency profiles.
- Reteach and retest if necessary.
- Review individual and group performance in order to evaluate teaching methods. Adjust scope, sequence, or instructional approaches for additional lessons as required.

SUGGESTED RESOURCES

Print Media

- Chown Hardware & Machinery. 1987-88 Catalog, *Greenlee Catalog #47*. P.O. Box 2888, 333 N.W. 16th Avenue, Portland, Oregon 97208.
- Klein Tools and Occupational Protective Equipment, *General Catalog #129*. 7200 McCormick Boulevard, Chicago, Illinois 60645.

UNIT REFERENCES

- Colvin, Thomas S. *Electrical Wiring*, American Association for Vocational Instructional Materials: 220 Smithonia Rd., Winterville, GA 30683.

INFORMATION SHEET	ELECTRICAL TOOLS	A 2

OBJECTIVE 1

Given a list of terms associated with electrical tools, match them to their correct definitions.

- **deburring** — process of removing burrs (roughness) caused from the cutting of metal
- **electrical continuity** — the ability of a conductor to pass electricity
- **EMT** — electrical metallic tubing (conduit)
- **OSHA** — Occupational Safety and Health Administration
- **resistance** — opposition to the flow of electricity in a conductor or circuit
- **set-out** — distance that electrical boxes extend past the studs
- **splicing** — joining together of two or more conductors

OBJECTIVE 2

Complete statements concerning the safe use and care of electrical tools.

- Always follow OSHA rules and regulations.
- Use the correct tool for the job.
- Keep tools clean.
- Repair broken or damaged tools promptly.
- Dispose of broken or damaged tools that cannot be repaired.
- Store tools properly when not in use.
- Stay alert when using tools around electricity.
- Wear eye protection when necessary.

- Use hand tools with insulated handles.
- Never open electrical access panels unless you are trained and qualified in electricity and electrical safety.
- Keep cutting tools sharp and in good working condition.
- Keep all cutting edges properly protected.
- Keep moving parts properly lubricated.
- Inspect tools and accessories regularly.
- Avoid bumping or jolting meters and testing equipment.
- Avoid exposure of meters and testing equipment to extreme temperature.
- Keep yourself, tools, and equipment dry when working around electricity.
- Use GFCI equipped circuits or extension cords on AC powered tools.

OBJECTIVE 3 **Given a drawing, match them to the title of electrical tools.**

- Common personal protection equipment used by electricians
  - — Hard hat

FIGURE 1

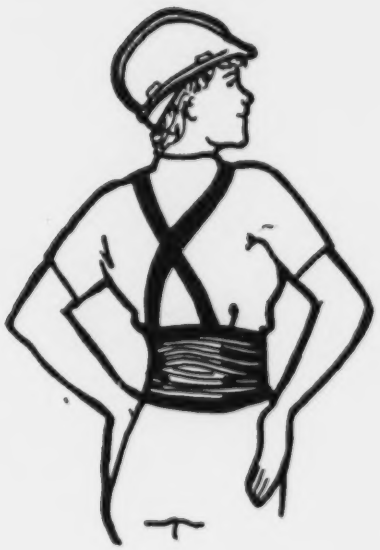
— Safety goggles

FIGURE 2

— Back braces

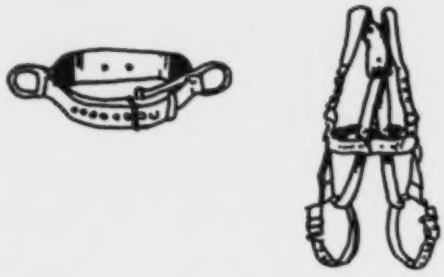
FIGURE 3

FIGURE 4



— Safety harness

FIGURE 5



— Lockout devices

FIGURE 6

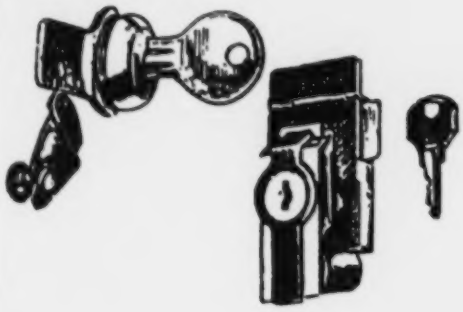
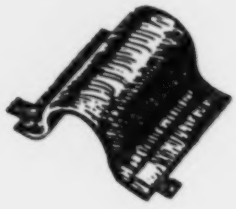


FIGURE 7



NOTE: Lockout devices prevent activation of circuits while being worked on. Many types are available and electricians are required to use them to protect personnel from accidental electrical shock.

- Folding rule or steel tape — used to check measurements on prints, locate boxes, and determine depth and set-out (Figures 8-9)

FIGURE 8

FIGURE 9

- Screwdrivers

  — Flat blade (standard) screwdriver — used to remove and install slot head screws and to tighten and loosen slot head lugs (Figure 10)

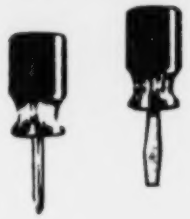
FIGURE 10

  — Phillips head screwdriver — used to remove and install Phillips head screws and to tighten and loosen Phillips head lugs (Figure 11)

FIGURE 11

— Stubby screwdriver — used to remove and install screws in limited working space and to tighten and loosen lugs in limited working space (Figure 12)

FIGURE 12



- Pliers

— Sidecut pliers — used to cut cables, conductors, small screws; strip conductors; form large conductors; and pull and hold conductors (Figure 13)

FIGURE 13

— Long-nose or needle-nose pliers — used to form small conductors, strip conductors, cut conductors, and to hold and pull conductors (Figure 14)

FIGURE 14

— Diagonal pliers — used to cut cables and conductors in limited space and to strip conductors (Figure 15)

FIGURE 15

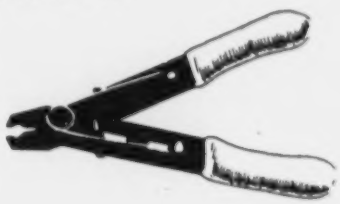
— Channel-lock pliers (groove-lock) — used to hold and tighten couplings and connectors and to hold and turn conduit and tubing (Figure 16)

FIGURE 16

- Miscellaneous hand tools

— Adjustable wire strippers — used to strip insulation from conductors and to cut and form conductors (Figure 17)

FIGURE 17



— Six-in-one tool — used to strip insulation, cut conductors, and to cut small bolts (Figure 18)

FIGURE 18

— Tap tool — used to tap holes for securing equipment to metal, enlarge holes and tap for larger screws, retap damaged threads, and to determine screw sizes (Figure 19)

FIGURE 19

— Adjustable wrench — used to tighten couplings and connectors, tighten pressure-type wire connectors, and to remove and hold nuts and bolts (Figure 20)

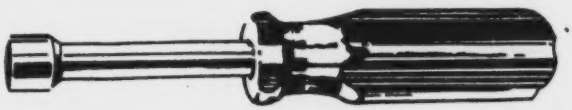
FIGURE 20

— Awl — used to start screw holes, make pilot holes for drilling, and to mark metal (Figure 21)

FIGURE 21

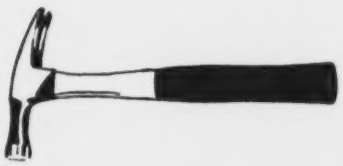
— Nut driver — used to remove and install hex headed screws/bolts/nuts in limited working space. Available in several sizes from 3/16"-5/8". (Figure 22)

FIGURE 22



— Hammer — used to drive and pull nails, pry boxes loose, chip wood, break wall board, and to strike chisels (Figure 23)

FIGURE 23



— Voltage tester — used to check for live circuits and to identify conductors (Figure 24)

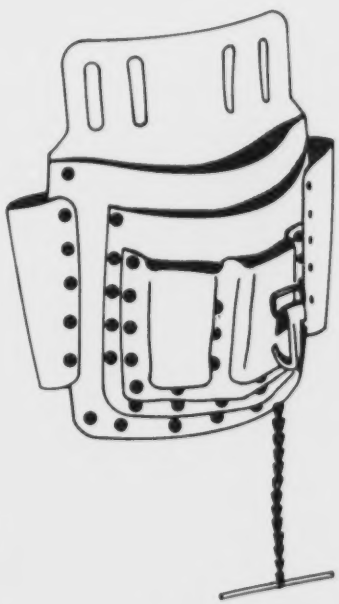
FIGURE 24

— Hacksaw — used to cut EMT, pipe, and large conductors and cables (Figure 25)

FIGURE 25

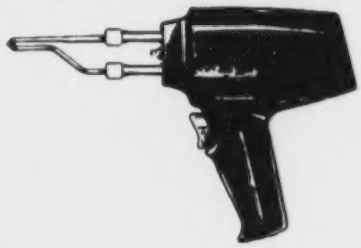
— Tool pouch — used to hold, organize, and carry electrician's tools (Figure 26)

FIGURE 26



— Soldering gun — used to splice conductors when required (Figure 27)

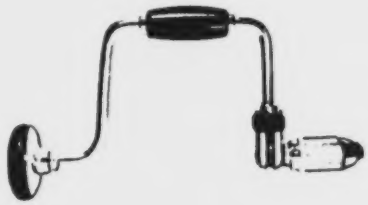
FIGURE 27



NOTE: Many soldering guns provide levels of increased heat—controlled by depressing the trigger.

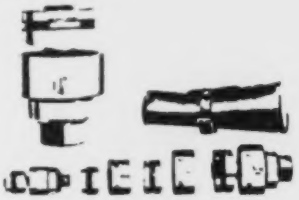
— Boring brace — used to manually bore holes for cables, conduits, and pipe (Figure 28)

FIGURE 28



— Knockout punch — used to cut holes for cable or conduit fittings in metal boxes, equipment, and appliances and for enlarging holes in metal boxes, equipment, and appliances (Figure 29)

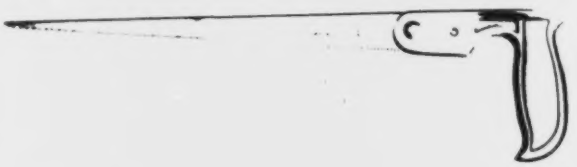
FIGURE 29



NOTE: Hydraulic and ratchet knockout punches are also available.

— Keyhole saw — used to cut holes in drywall for boxes and to cut exposed lath for box installation (Figure 30)

FIGURE 30



— Hickey bender — used to bend heavy wall conduit (Figure 31)

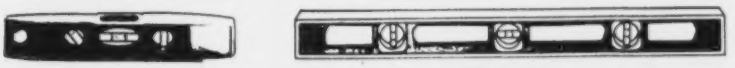
FIGURE 31

— EMT bender — used to bend EMT (Figure 32)

FIGURE 32

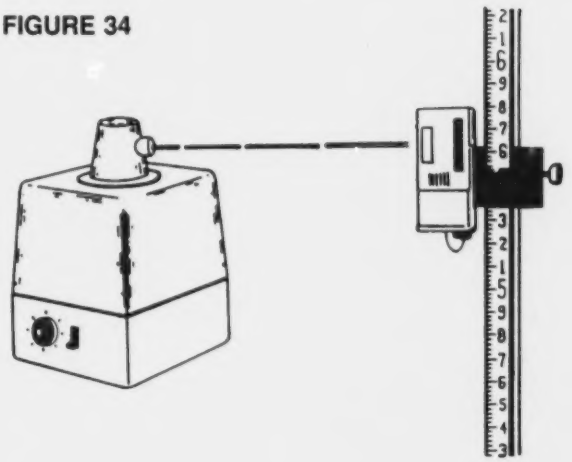
— Level — used to level or plumb conduit, equipment, and appliances (Figure 33)

FIGURE 33



— Laser transit

FIGURE 34



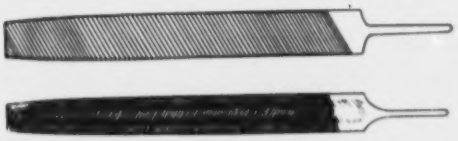
NOTE: Use of a laser transit requires operator certification.

— Fish tape and reel — used to pull wires or cables through conduit and to pull cables up insulated walls (Figure 35)

FIGURE 35

— File — used to deburr conduit, sharpen tools, and cut and form metal (Figure 36)

FIGURE 36

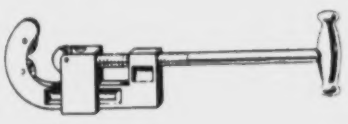


— Chisel — used to notch wood for boxes and cables (Figure 37)

FIGURE 37

— Pipe cutter — used to cut pipe and conduit (Figure 38)

FIGURE 38



— Pipe reamer — used in a bit brace or machine to deburr pipe and conduit (Figure 39)

FIGURE 39

— Cable cutter — used to cut large size cables (Figure 40)

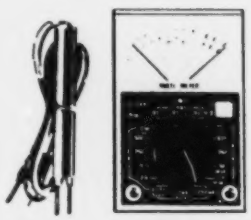
FIGURE 40

— Pipe vise and stand — used to hold pipe and conduit while cutting and deburring and to hold pipe while threading (Figure 41)

FIGURE 41

— Volt ohmmeter — used to measure circuit voltage and resistance and to check for voltage and continuity (Figure 42)

FIGURE 42



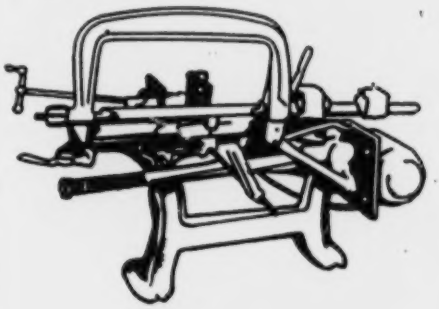
— Digital clamp-on ammeter — used to check amperage, individual load amperage, and motor starting and running current (Figure 43)

FIGURE 43

- Power tools

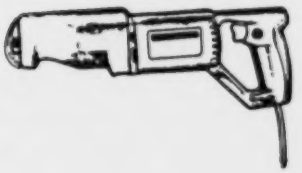
— Power hack saw

FIGURE 44



— Reciprocating saw

FIGURE 45

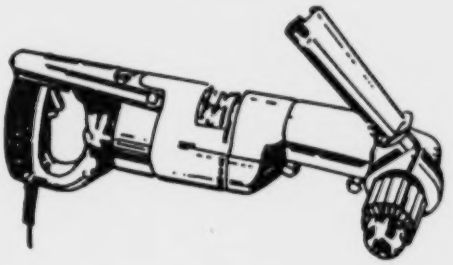


— Coreless drill

FIGURE 46

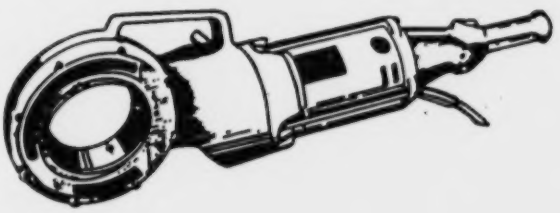
— Right angle drill

FIGURE 47



— Power pipe treading machine

FIGURE 48



JOB SHEET 1	ELECTRICAL TOOLS	A 2

NAME _____ SCORE _____

OBJECTIVE 4

Adjust wire strippers.

INTRODUCTION

There are several types of wire strippers available to electricians. The strippers used in this exercise are quite common and require a standard screwdriver to adjust the depth of cut.

The goal is to strip away the insulation without cutting or nicking the metal conductor.

TOOLS AND EQUIPMENT

- Hard hat and goggles or safety glasses
- Adjustable wire strippers
- 12 or 14 AWG solid insulated conductor
- Standard screwdriver

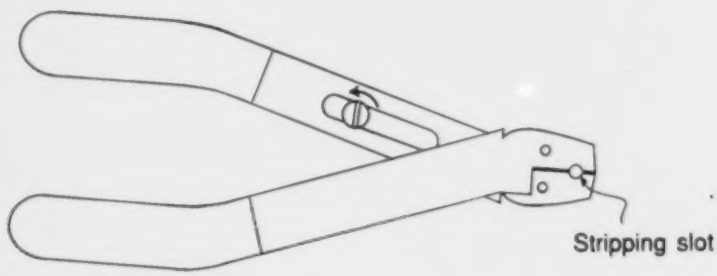
PROCEDURE

Functional Reading
- Follow written instructions
- Interpret graphics and symbols

Job Acquisition/ Development
- Master specific job task/procedure
- Practice good work habits/attitudes

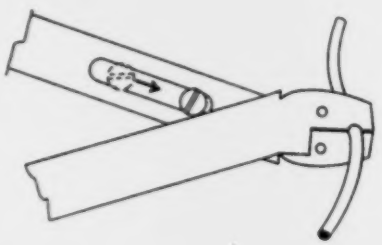
	Yes	No
1. Put on safety equipment.	___	___
2. Loosen adjustment screw. (Figure 49)	___	___

FIGURE 49



	Yes	No
3. Insert conductor in stripping slot.	___	___
4. Close jaws until you feel that you have reached the conductor.	___	___
5. Open the jaws slightly.	___	___
6. Slide the adjustment screw down to its resting position. (Figure 50)	___	___

FIGURE 50



7. Strip off a fresh piece of insulation.	___	___
8. Check conductor for ring or nick. (Figure 51)	___	___

NOTE: If nick occurs, loosen adjustment screw, move it back slightly, retighten, and test again until insulation is cut without conductor damage.

FIGURE 51

Correctly adjusted

Incorrectly adjusted

	Yes	No
9. Practice stripping several sizes of wire until you can do it without cutting or nicking the metal conductor. **NOTE:** Wires that have been nicked may break at a later date. Always cut the nicked wire and restrip.	___	___
10. Ask your instructor to evaluate your work.	___	___
11. Put away all tools and equipment.	___	___

(End of Job Sheet)

SKILL TEST RECORD

EVALUATOR'S COMMENTS

_____

_____

_____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Safety equipment used	4	3	2	1
Wire stripped properly	4	3	2	1

EVALUATOR'S COMMENTS

_____

_____

_____

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 **Skilled** — Can perform job with no additional training
3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required
2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill
1 **Unskilled** — Is familiar with process, but is unable to perform job

JOB SHEET 2	ELECTRICAL TOOLS	A 2

NAME _____ SCORE _____

OBJECTIVE 5

Trim conductor insulation using a knife.

INTRODUCTION

Removing conductor insulation using a knife must be done with care. Painful cuts have resulted from using improper procedures.

TOOLS AND EQUIPMENT

- Hard hat and goggles
- Pocket knife
- Insulated conductor

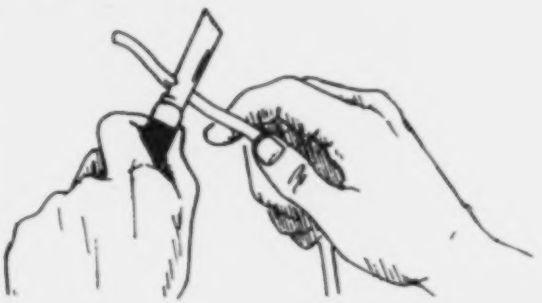
PROCEDURE

Functional Reading
- Follow written instructions
- Interpret graphics and symbols

Job Acquisition/ Development
- Master specific job task/procedure
- Practice good work habits/attitudes

	Yes	No
1. Put on safety equipment.	___	___
2. Place knife blade on length of insulation to be removed. (Figure 52)	___	___

FIGURE 52



CAUTION: Never cut toward yourself when trimming conductor insulation.

Yes No

3. Push knife through stroke to remove chip. (Figure 53) — —

   NOTE: Be careful and do not nick your conductor in this process.

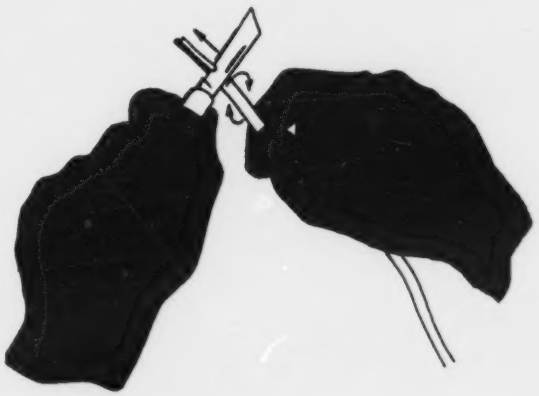
FIGURE 53

4. Rotate the conductor. — —

5. Remove another chip. (Figure 54) — —

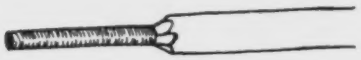
   NOTE: Try to start all knife strokes evenly.

FIGURE 54



	Yes	No
6. Rotate and trim until insulation is removed. (Figure 55)	___	___

FIGURE 55



7. Practice this procedure several times.	___	___
8. Ask your instructor to evaluate your work.	___	___
9. Put away all tools and clean up your work area.	___	___

(End of Job Sheet)

SKILL TEST RECORD

EVALUATOR'S COMMENTS

_____

_____

_____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Safety equipment used	4	3	2	1
Wire properly stripped	4	3	2	1

EVALUATOR'S COMMENTS

_____

_____

_____

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 **Skilled** — Can perform job with no additional training
3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required
2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill
1 **Unskilled** — Is familiar with process, but is unable to perform job

JOB SHEET 3	ELECTRICAL TOOLS	A 2

NAME _____ SCORE _____

OBJECTIVE 6

Use a soldering gun to splice conductors.

INTRODUCTION

The metal conductors used in cables tend to corrode over time. This may result in poor connection without properly soldering the conductors after joining.

TOOLS AND EQUIPMENT

- Hard hat and goggles
- Soldering gun
- Sidecut pliers
- Wire strippers
- Rosin core solder
- Copper conductors

NOTE: Soldering conductors is normally not required in most localities. Wire nuts, crimp-connectors, and lug splicers are often used as the preferred method to join or splice wiring.

PROCEDURE

		Yes	No
1.	Put on hard hat and goggles.	___	___

Functional Reading
- Follow written instructions
- Interpret graphics and symbols

CAUTION: NEVER try to solder wiring that has electricity flowing through it. Electrical shock could result.

2.	Strip approximately 1" of insulation from the conductor.	___	___
3.	Form a splice using the straight or twist splice methods.	___	___

NOTE: Any solid splice will work. Two types are illustrated here.

Math Application
- Use English and metric measures

Job Acquisition/ Development

- Master specific job task/procedure
- Practice good work habits/attitudes

Yes No

4. Using the straight splice method,

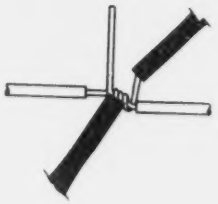
   A. Bend 90-degree angles in both conductors. (Figure 56) ___ ___

   B. Hook conductors together. (Figure 56) ___ ___

FIGURE 56

   C. Continue by wrapping one conductor around the other with the sidecut pliers. (Figure 57) ___ ___

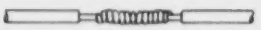
FIGURE 57



Yes No

D. Finish wrapping until the splice forms a smooth appearance. (Figure 58) ___ ___

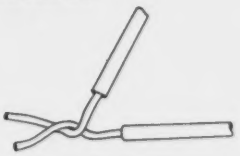
FIGURE 58



5. Using the twist splice method,

A. Lap conductors over each other. (Figure 59) ___ ___

FIGURE 59



B. Twist tightly. (Figure 60) ___ ___

FIGURE 60

6. Clean tip of soldering gun. ___ ___

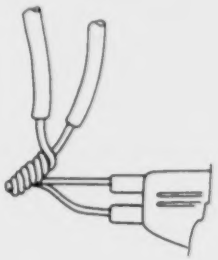
Yes No

7. Heat gun tip. ___ ___

CAUTION: You can touch the solder to the gun tip to determine if it is hot enough. DO NOT touch the tip of the gun with your fingertips; severe burns will result.

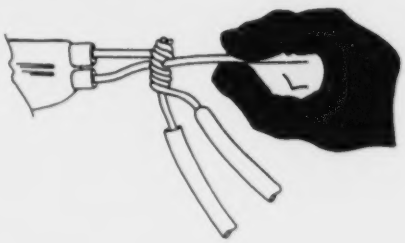
8. Put gun tip on underside of splice to heat it. (Figure 61) ___ ___

FIGURE 61



9. Apply solder to top of joint. (Figure 62) ___ ___

FIGURE 62



	Yes	No
10. Remove soldering gun and solder stick from joint when it has filled. **NOTE:** Be sure the solder easily flows throughout the splice. This ensures a cold solder joint is *not* made.	___	___
11. Have the instructor inspect the splice.	___	___
12. Clean up tools and replace.	___	___

(End of Job Sheet)

SKILL TEST RECORD

EVALUATOR'S COMMENTS

_____

_____

_____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Safety equipment used	4	3	2	1
Wire not nicked	4	3	2	1
Splice wrapped properly	4	3	2	1
Solder flowed throughout splice	4	3	2	1

EVALUATOR'S COMMENTS

_____

_____

_____

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 **Skilled** — Can perform job with no additional training
3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required
2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill
1 **Unskilled** — Is familiar with process, but is unable to perform job

JOB SHEET 4	ELECTRICAL TOOLS	A 2

NAME _____ SCORE _____

OBJECTIVE 7

Cut and ream rigid conduit.

INTRODUCTION

During this exercise you will cut and ream rigid conduit using common tools of an electrician.

TOOLS AND EQUIPMENT

- Hard hat and goggles
- Pipe vise
- Pipe cutter
- Rigid conduit
- Pencil
- Reamer

CAUTION: Rigid conduit has sharp edges that can cause painful cuts.

PROCEDURE

Functional Reading
- Follow written instructions
- Interpret graphics and symbols

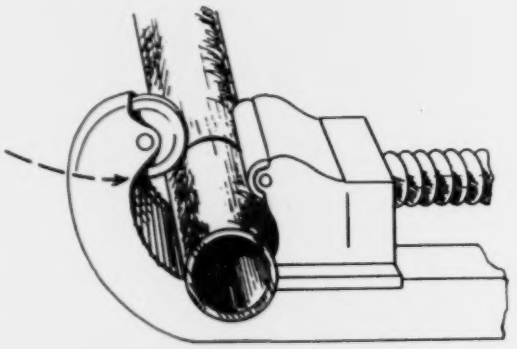
		Yes	No
1.	Put on safety equipment.	___	___
2.	Secure conduit in vise.	___	___
3.	Mark place for cut with pencil.	___	___
4.	Open pipe cutter until it will fit over conduit.	___	___

Job Acquisition/ Development
- Master specific job task/procedure
- Practice good work habits/attitudes

Yes No

5. Locate cutter wheel on the pencil mark. (Figure 63) ___ ___

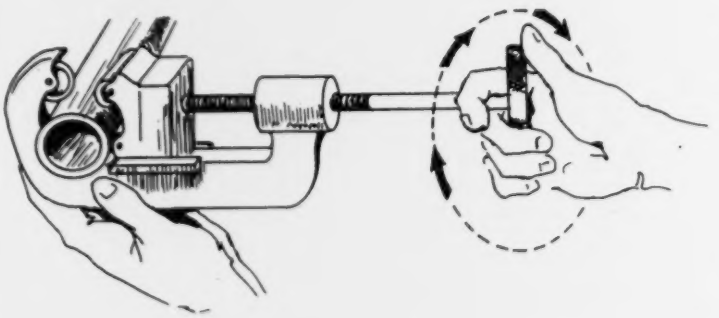
FIGURE 63



6. Snug cutter up to conduit by rotating screw handle. (Figure 64) ___ ___

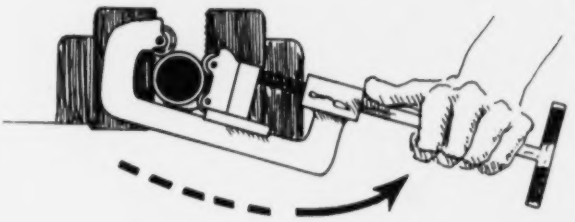
   NOTE: Don't overtighten as this can break cutter wheel.

FIGURE 64



	Yes	No
7. Rotate cutter counterclockwise to start groove. (Figure 65)	___	___

FIGURE 65



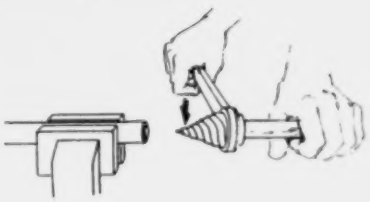
8. Tighten cutter screw handle ¼ of a turn for each full revolution around the pipe. **NOTE:** Overtightening can cause cutters to break.	___	___

CAUTION: When cutting short pieces of conduit, be careful not to cut your arm while rotating the cutter around the pipe.

9. Continue process until conduit is cut. **NOTE:** Be prepared to catch free piece of conduit.	___	___

	Yes	No
10. Insert reamer tip in conduit. (Figure 66)	___	___

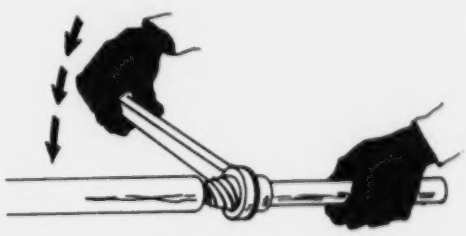
FIGURE 66



11. Apply light forward pressure to push reamer into conduit.	___	___
12. Start rotating reamer. (Figure 67)	___	___

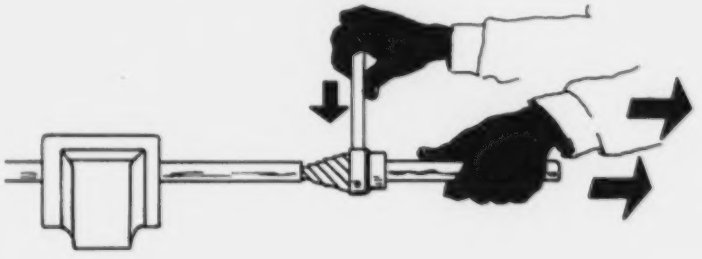
NOTE: Reamer should bite instantly if proper pressure is applied. Reamer can be damaged if rotated in the wrong direction.

FIGURE 67



	Yes	No
13. Rotate reamer until burrs are removed.	___	___
NOTE: This is a developed skill. The reamer can be pulled out and your progress inspected.		
14. Pull reamer back while continuing to rotate. (Figure 68)	___	___
NOTE: This prevents the reamer from leaving a burr.		

FIGURE 68



15. Have your instructor evaluate your work.	___	___
16. Put up all tools and equipment.	___	___

(End of Job Sheet)

SKILL TEST RECORD

EVALUATOR'S COMMENTS

_____

_____

_____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Safety equipment used	4	3	2	1
Conduit cut to proper length (±1/16")	4	3	2	1
Burrs removed	4	3	2	1

EVALUATOR'S COMMENTS

_____

_____

_____

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 **Skilled** — Can perform job with no additional training
3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required
2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill
1 **Unskilled** — Is familiar with process, but is unable to perform job

JOB SHEET 5	ELECTRICAL TOOLS	A 2

NAME _____ SCORE _____

OBJECTIVE 8

Use a volt ohmmeter.

INTRODUCTION

A volt ohmmeter can measure electrical continuity, voltages, resistance, and amperage.

Voltage and amperage reading must be done on live or hot circuits. Use extreme care to prevent electrical shock.

TOOLS AND EQUIPMENT

- Hard hat and goggles
- Volt ohmmeter
- 125-volt duplex grounding receptacle
- 250-volt grounding receptacle
- Assorted fuses

CAUTION: You must perform this exercise under the supervision of your instructor.

PROCEDURE

Functional Reading
- Follow written instructions
- Interpret graphics and symbols

		Yes	No
1.	Put on safety equipment.	___	___
2.	Read meter instructions.	___	___
	NOTE: Some meters require a specific probe connection at the meter.		
3.	Set meter at highest AC scale.	___	___

General Science
- Conduct experiments

Job Acquisition/ Development
- Master specific job task/procedure
- Practice good work habits/attitudes

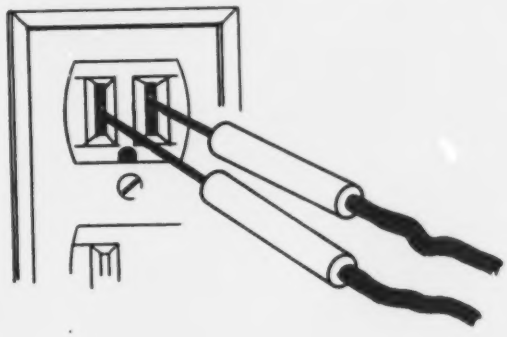
Yes No

4. Holding to the insulated part of the probes, check across neutral and hot slots of 120-volt duplex receptacle. (Figure 69) — —

   NOTE: If reading on highest scale does not exceed the next lower scale, drop to it for a more accurate reading. Repeat this process until you are reading on the lowest possible scale.

CAUTION: Connecting a meter that is set on a scale lower than the actual circuit voltage could damage the meter.

FIGURE 69

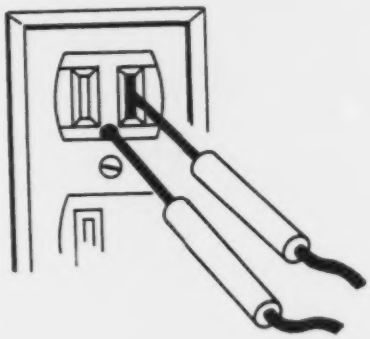


5. Check for 110-120 voltage across hot (shorter slot) and grounding slot. (Figure 70) — —

   NOTE: Again, start at the highest meter scale. A short in a multi-wire branch circuit can give a dual voltage reading in this test.

Yes No

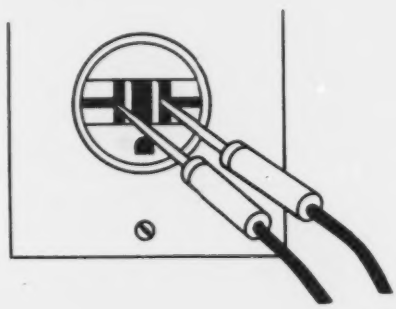
FIGURE 70



6. Reset meter to highest scale to measure a 240 volt receptacle. ___ ___

7. Check across hot slots of the receptacle. You should read about 240 volts. (Figure 71) ___ ___

FIGURE 71

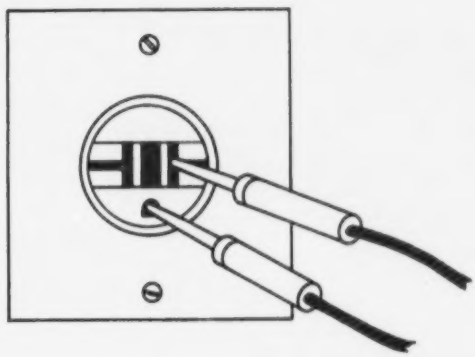


8. Reduce scale to most accurate possible reading. ___ ___

Yes No

9. Read from each hot conductor to the grounding conductor. You should measure 110-120 volts here. (Figure 72) — —

FIGURE 72



10. Remove the probes from the receptacle. — —

11. Change meter to ohm scale. — —

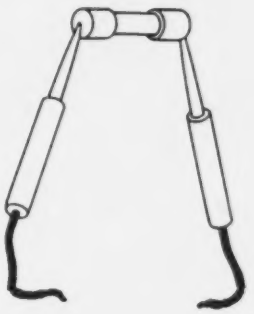
    NOTE: Never use the ohms scale to measure energized or hot circuits. Severe damage to the meter could result.

12. Measure across fuse contacts for continuity. (Figure 73) — —

    NOTE: A scale reading indicates that the fuse is good. No scale reading indicates the fuse is bad.

Yes No

FIGURE 73



13. This continuity test is also valuable to test cable continuity and the proper operation of switches. ___ ___

14. Ask your instructor to evaluate your performance. ___ ___

15. Put away all tools and equipment. ___ ___

(End of Job Sheet)

SKILL TEST RECORD

EVALUATOR'S COMMENTS

_____

_____

_____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Safety equipment used	4	3	2	1
Successfully measured voltages	4	3	2	1
Changed meter scales as instructed	4	3	2	1
All safety guidelines observed	4	3	2	1

EVALUATOR'S COMMENTS

_____

_____

_____

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 **Skilled** — Can perform job with no additional training
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2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill
1 **Unskilled** — Is familiar with process, but is unable to perform job

WRITTEN TEST	ELECTRICAL TOOLS	A 2

Name _____ Score _____

OBJECTIVE 1

Given a list of terms associated with electrical tools, match them to their correct definitions. Write the letter that corresponds to the most correct answer.

_____ 1. The ability of a conductor to pass electricity is

a. conductor stability
b. electrical continuity
c. bypass ability
d. connectability

_____ 2. The most common type of electricity found in both residential and commercial facilities is

a. alternating current (AC)
b. direct current (DC)
c. amperage current (AC)
d. distant current (DC)

_____ 3. The joining of two or more conductors is called

a. splicing
b. jointing
c. joining
d. linking

_____ 4. The distance that electrical boxes extend past the studs is their

a. offset
b. extended point
c. set-out
d. depth-of-field

May be photocopied for student use.

_____ 5. The opposition to the flow of electricity in a conductor or circuit is called

a. amperage
b. "R" factor
c. resistance
d. compression

_____ 6. The removal of sharp edges that are caused by the cutting of metal is called

a. raking
b. leveling
c. EMT transfer
d. deburring

OBJECTIVE 2 **Complete statements concerning the safe use and care of electrical tools.**

_____ 1. Hand tools must have

a. insulated handles
b. short handles
c. un-insulated handles
d. plastic tips

_____ 2. Workers must _____ _____ when using tools around electricity.

a. wear respirators
b. avoid others
c. unground extensions
d. stay alert

_____ 3. Keep yourself, tools, and equipment _____ when working around electricity.

a. wet
b. dry
c. grounded
d. covered

May be photocopied for student use.

_____ 4. Never open _____ _____ _____ unless you are trained and qualified in electricity and electrical safety.

a. circuit breaker doors
b. fuse box doors
c. phone wall plugs
d. electrical access panels

_____ 5. Use the _____ tool for the job.

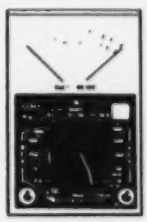
a. nearest
b. largest
c. correct
d. OSHA approved

_____ 6. Always follow _____ and company safety rules and regulations.

a. DOD
b. OSHA
c. EMT
d. EPA

OBJECTIVE 3 **Given drawings, match them to the titles of electrical tools.**

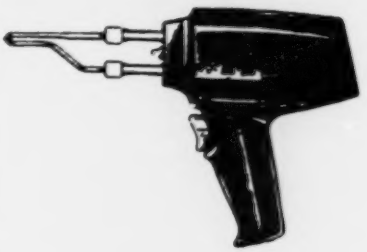
_____ 1. The tool shown below is a/an



a. clamp-on ammeter
b. deburr tool
c. EMT gage
d. volt ohmmeter

May be photocopied for student use.

_____ 2. The tool shown is a



a. soldering iron
b. soldering wand
c. power drill
d. soldering gun

_____ 3. This tool is commonly known as a

a. clamp-on ammeter
b. pipe vise
c. volt ohmmeter
d. soldering densitometer

_____ 4. The tool shown below is called a/an

a. voltage lamp
b. overcurrent indicator
c. voltage tester
d. pen light tester

May be photocopied for student use.

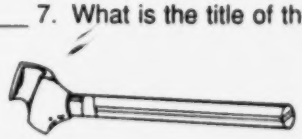
_____ 5. This tool is used to pull wire and cable through conduit and is a

a. pull string with reel
b. fish tape and reel
c. conduit reel
d. round pull reel

_____ 6. The tool below is known as a

a. bolt cutter
b. pipe cutter
c. pipe vise
d. cable cutter

_____ 7. What is the title of the tool shown below?



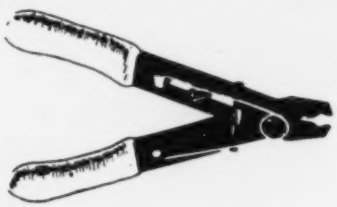
a. hickey bender
b. pipe vise
c. EMT bender
d. clamp-on cutter

May be photocopied for student use.

_____ 8. This tool is called a

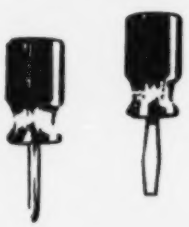
a. six-in-one tool
b. adjustable wire strippers
c. hand die
d. multi-purpose cutter

_____ 9. The tool pictured below is a/an



a. six-in-one tool
b. adjustable wrench
c. adjustable wire strippers
d. cable cutters

_____10. These tools are best known as



a. short screwdrivers
b. stubby screwdrivers
c. long scribes
d. short scribes

OBJECTIVES 4-8

These objectives are evaluated through the completion of job sheets.

May be photocopied for student use.

WRITTEN TEST ANSWERS

ELECTRICAL TOOLS — A 2

Name _____ Score _____

OBJECTIVE 1

1. b
2. a
3. a
4. c
5. c
6. d

OBJECTIVE 2

1. a
2. d
3. b
4. d
5. c
6. b

OBJECTIVE 3

1. d
2. d
3. a
4. c
5. b
6. d
7. a
8. a
9. c
10. b

OBJECTIVES 4-8

These objectives are evaluated through the completion of job sheets.

May be photocopied for student use.

CIMC
TEST CODE SHEET

VOCATIONAL PROGRAM (BOOK TITLE) INTRODUCTION TO ELECTRICITY

UNIT NUMBER AND TITLE – A2 – ELECTRICAL TOOLS

TOTAL NUMBER OF TEST QUESTIONS 22

TOTAL NUMBER OF BASIC SKILL QUESTIONS 5

OBJECTIVE NUMBER	TEST QUESTION NUMBER(S)	BASIC SKILL CODE(S)
1	1, 2, 5	S
1	3, 4, 6	X
2	1-6	X
3	1, 4	S
3	2, 3, 5-10	X
4-8	Evaluated on Job Sheets	

OBJECTIVE SHEET	APPLIED SKILLS	A 3

INTRODUCTION

This unit introduces you to the many skills required of an electrician. It discusses a typical AC distribution system found in residential buildings.

It should be understood that the National Electrical Code (NEC) and local electrical codes are the authority when performing any type of electrical work. This document should provide you the basic knowledge and skills needed to assist in your understanding of those codes.

PREREQUISITE

Fundamentals of Construction

UNIT OBJECTIVE

After completing this unit, the student will be able to perform basic skills of an electrician. The student will demonstrate these competencies by completing the assignment sheet, job sheets, and written test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES

After completing this unit, the student will be able to show the ability to:

1. Given a list of terms associated with electrical skills, match them to their correct definitions.
2. Given incomplete statements, choose the words that correctly complete electricity safety guidelines.
3. Given a diagram, select the correct titles of major components of an AC power distribution system.
4. Complete statements that define the rules for simple series and parallel circuits.
5. From a list, choose those steps required to provide equipment grounding to devices and equipment within a power distribution system.

6. Select the correct methods to wire electrical receptacles, switches, and lighting.

7. Match electrical schematic symbols to their titles. (Assignment Sheet)

8. Install a duplex grounding type receptacle and a plate. (Job Sheet 1)

9. Wire a single pole switch and light. (Job Sheet 2)

10. Wire a receptacle fed from a lighting outlet through a single pole switch. (Job Sheet 3)

SUGGESTED ACTIVITIES	APPLIED SKILLS	A 3

PREPARATION

- Review unit and plan presentation.
- Order or obtain materials to supplement unit.
- Introduce unit.

DELIVERY

Objective 1: Given a list of terms associated with electrical skills, match them to their correct definitions.

- Use Information Sheet to discuss terms and definitions associated with electrical layout.
- Discuss, show samples of, or demonstrate terms that may be unfamiliar to students.
- Have students review terms.

Objective 2: Given incomplete statements, choose the words that correctly complete electricity safety guidelines.

- Stress the importance of safety, particularly when working with live circuits.
- Obtain safety signs and posters to display in class.

  NOTE: Various safety educational material and filmstrips are available from Underwriters Laboratories, Inc., Public Information and Education Services, 207 East Ohio Street, Chicago, IL 60611.

- Show video tape *Electrical Safety*.

Objective 3: Given a diagram, select the correct titles of major components of an AC power distribution system.

- Use the Information Sheet to describe the major components of an AC power distribution system.

- Use Transparencies 1-3 to discuss fuses and circuit breakers.

Objective 4: Complete statements that define the rules for simple series and parallel circuits.

- Use the Information Sheet to discuss series and parallel circuits.
- Use Transparencies 4 and 5 if a more detailed explanation is desired.

Objective 5: From a list, choose those steps required to provide equipment grounding to devices and equipment within a power distribution system.

- Display a mock-up of the equipment grounding circuit.
- Have students identify parts of this circuit; demonstrate the procedures for putting this together.
- Discuss parts of the equipment grounding circuit.
- Discuss NEC requirements and codes pertaining to grounding.

Objective 6: Select the correct methods to wire electrical receptacles, switches, and lighting.

- Put together a mock-up of the different switching circuits; have students identify the different parts, then discuss how they go together and how they are used.
- Use the National Electrical Code manual to discuss installation requirements.
- Describe any local or state electrical codes that may apply to installation.
- Explain to your students that this is not a licensing course—most state and local governments require an electrician's license before any work can be performed.

APPLICATION

Objective 7: Match electrical schematic symbols to their titles. (Assignment Sheet 1)

- Use Information Sheet to discuss electrical schematic symbols.
- Select plans obtained to supplement unit and have students identify the different symbols found on the plans.
- Have students review the schematic symbols found in the information section.
- Ask students to complete the Assignment Sheet.

Objective 8: Install a duplex grounding type receptacle and a plate. (Job Sheet 1)

Objective 9: Wire a single pole switch and light. (Job Sheet 2)

Objective 10: Wire a receptacle fed from a lighting outlet through a single pole switch. (Job Sheet 3)

- Allow students to practice the procedures in the job sheets.
- Be sure to closely supervise students to ensure all safety guidelines are followed.

EVALUATION

Pretest

- Give written test as pretest.
- Determine individual study requirements from pretest results.
- Counsel students individually on pretest results and study requirements.
- Modify materials in unit or create supplementary materials for individual students as required.

Skill Test

- Evaluate students on assignment sheet activities.
- Evaluate students on job sheet activities.
- Complete appropriate section of competency profiles.
- Reteach and reevaluate if necessary.
- Modify materials in unit or create supplementary materials for individual students as required.

Written Test

- Explain to students that they will be asked to demonstrate on the written test actions listed in the specific objectives.
- Give the written test.

  NOTE: The written test may be given in sections if desired.
- Complete appropriate sections of competency profiles.
- Reteach and retest if necessary.
- Review individual and group performance in order to evaluate teaching methods. Adjust scope, sequence, or instructional approaches for additional lessons as required.

SUGGESTED RESOURCES

Print Media

- *National Electrical Code*, National Fire Protection Association, Inc., Quincy, MA 02269.

Electronic Media

- *Electrical Safety*. Oklahoma Department of Vocational and Technical Education, 1500 W. 7th, Stillwater, OK 74074. (VAS, 29 min.)

UNIT REFERENCES

- Colvin, Thomas S. *Electrical Wiring.* American Association for Vocational Instructional Material: 220 Smithonia Road, Winterville, GA. 30683.
- Taylor, Mark. *Residential Wiring.* Stillwater, Oklahoma: Mid-America Vocational Curriculum Consortium, Inc.
- Toenjes, Leonard P. *Building Trades Dictionary.* American Technical Publishers, Inc.: Homewood, IL 60430.

INFORMATION SHEET	APPLIED SKILLS	A 3

OBJECTIVE 1

Given a list of terms associated with electrical skills, match them to their correct definitions.

- **branch circuits** — wiring leading from the load center that connects AC to devices, household appliances, etc.
- **cable clamp** — piece of equipment used to secure cables
- **equipment grounding conductor** — the conductor used to connect devices and appliance frames to earth ground
- **grounded conductor** — the white conductor often designated as the "neutral" wire
- **grounding electrode conductor** — conductor used to connect the grounding electrode to the equipment grounding conductor and/or the grounded conductor of the circuit at the service
- **hertz (Hz)** — unit of frequency equal to one cycle per second (60 Hz is the most common AC frequency used)
- **local electrical codes** — written codes that specify standards for safe electrical installations
- **NEC (National Electrical Code)** — written articles which provide minimum standards for safe installations and practical safeguarding of persons and property from hazards arising from the use of electricity
- **parallel circuit** — electrical circuit with all loads installed across circuit conductors
- **poles** — current carrying conductors, both grounded and ungrounded, on a receptacle

- **return leg** — conductor that carries electrical energy from the switch to the load

  NOTE: Terminology relating to these conductors may vary in the field.

- **series circuit** — electrical circuit with all loads installed in a single path

- **service** — conductors and equipment for delivering energy from the electric supply system to the wiring system of the premises to be served

- **service raceway** — conduit that encloses the service entrance conductors

- **service lateral** — underground service conductors between the street main, including any risers at a pole or other structure, or from transformers and the first point of connection to the service entrance conductors

- **service drop** — overhead service conductors from the last pole or other aerial support to and including the splices, if any, connecting to the service entrance conductors at the building or other structure

- **straps or yokes** — metal tab at the top and bottom of devices so they may be secured to boxes

- **switch loop** — conductor between light and switch when supply enters the light

- **switch leg** — conductor that supplies electrical energy to a switch

- **terminal** — point of electrical attachment for conductors

- **ungrounded conductor** — the black conductor often designated as the "HOT" wire

OBJECTIVE 2

Given incomplete statements, choose the word that correctly complete electricity safety guidelines.

NOTE: These electricity safety guidelines have a goal to inform you of the most common safety rules and regulations before performing any electrical work.

- Rules for electrical installation
  - — Always be safety conscious.
  - — Be sure all connections are secure and well insulated.
  - — Always be sure that branch overcurrent protection is matched to your conductor rating.
  - — Preform conductors before installing devices in boxes.
  - — Use appropriate tools, such as those with insulated handles.
  - — Always meet or exceed NEC and local electrical code minimum installation requirements.
  - — Watch out for electrical arcs; they can cause bad burns.
  - — Remember that mild shocks can cause personal injury or injury to others by your reaction.
  - — Never install equipment that will overload a circuit.
  - — Never bypass a fuse or circuit breaker.
  - — Be sure all electrical lines carrying current are well insulated.

- Live circuits

  — Always check a circuit for voltage before servicing. Trip the breaker, lock the load center door, and/or disconnect the circuit before servicing.

  — Work on live circuits only when absolutely necessary.

  — Use a neon test light or voltmeter to identify live circuits before you begin work.

  — Stand on dry surface when working with live circuits.

  — Use only one hand if possible. This reduces the chance that you will receive an electrical shock.

  — Wear suitable insulated hand coverings.

  — Never keep tools lying around live conductors.

  — Return all tools to pouch when through working with them.

- Electrical shock

  — Never underestimate the danger of 120-volt AC circuits. Review Table 1 below to increase your respect for electricity.

    NOTE: More people die from 120-volt electrical shock than any other voltage. This is due mostly to a lack of respect.

TABLE 1: Effects of Electrical Shock

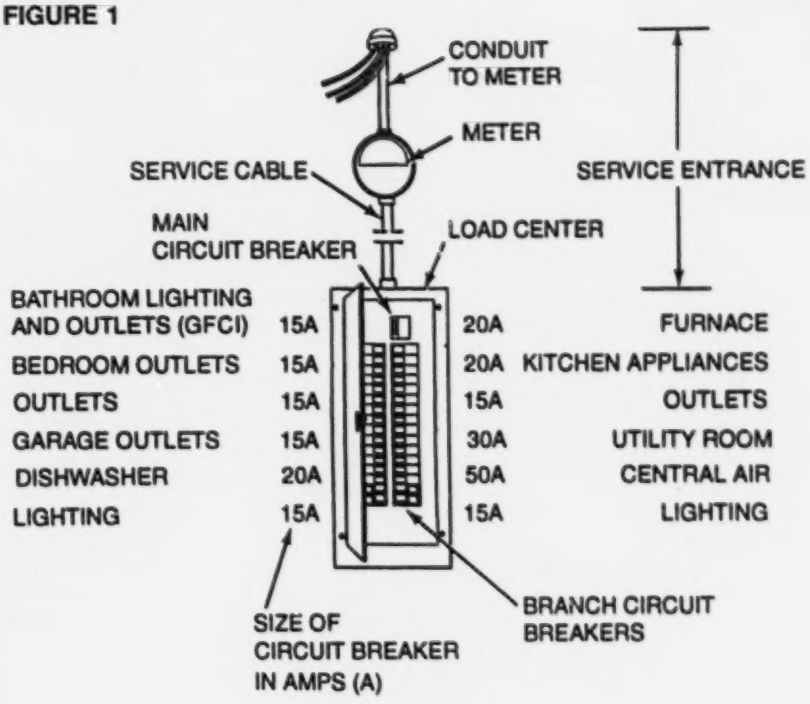
Amperage at 60 Hz	Effect
.0005 or less amperes	No sensation
.0005 to .002 amperes	Threshold of perception
.002 to .010 amperes	Muscular contraction (mild to strong)
.005 to .025 amperes	Painful shock, inability to let go
.025 to more amperes	Violent muscular contraction
.050 to .200 amperes	Ventricular fibrillation (convulsive movement of the heart—fatal)
Over .100 amperes	Paralysis of breathing (apply artificial respiration immediately)

OBJECTIVE 3

Given a diagram, select the correct title of major components of an AC power distribution system.

- AC power distribution systems (Figure 1) consists of:
  - — Service entrance
  - — Load center
  - — Overcurrent protection
  - — Branch circuits
  - — Devices

FIGURE 1

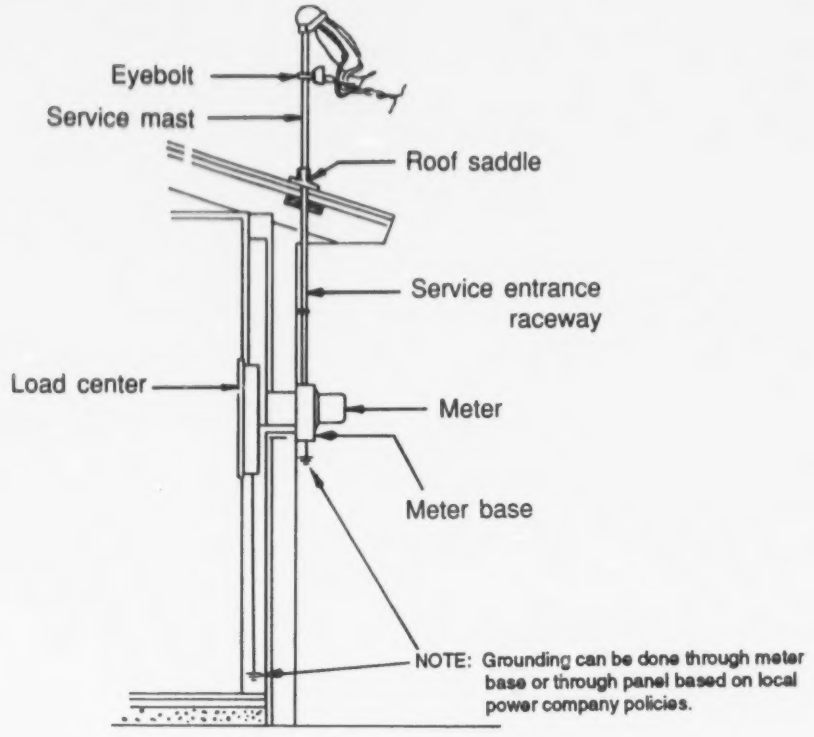


NOTE: National and local electrical codes require GFCI breakers to be installed on specified branch circuits.

- Service entrance

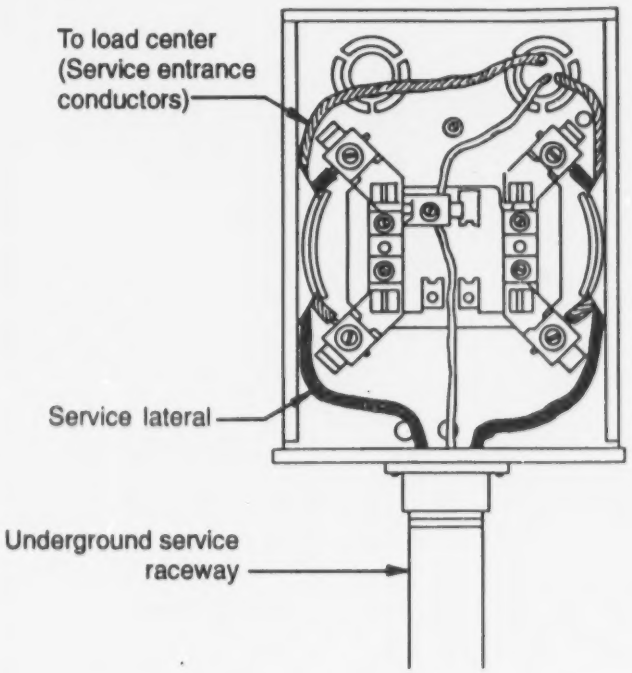
— Overhead service (Figure 2)

FIGURE 2



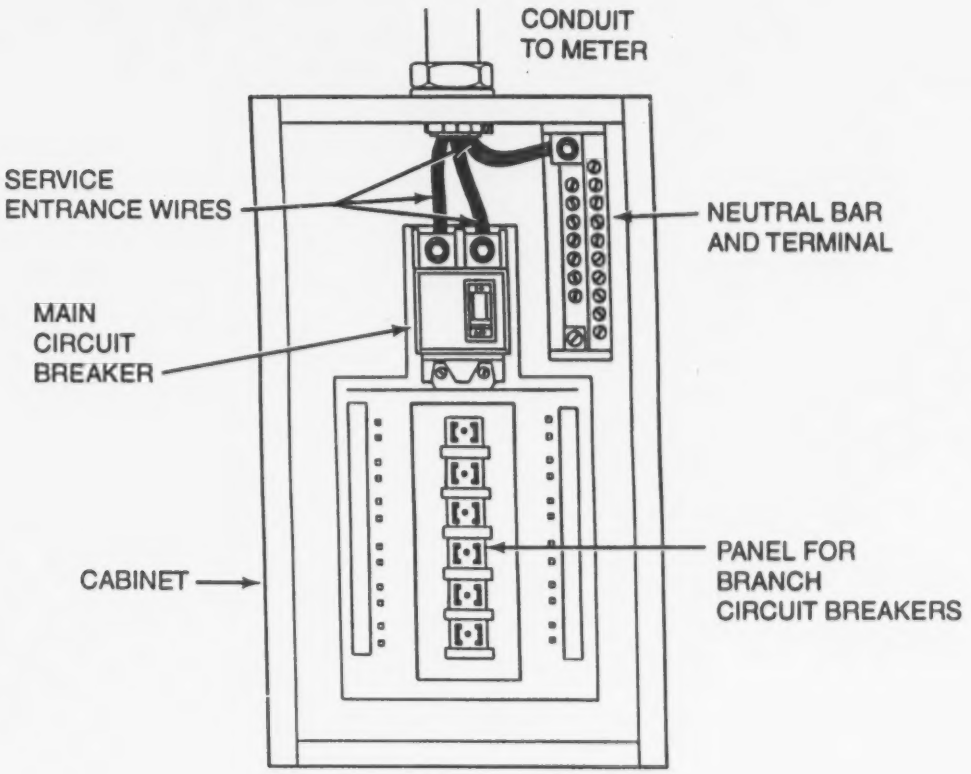
— Underground service (Figure 3)

FIGURE 3



- Load center (Figure 4)

FIGURE 4



- Overcurrent protection
  - — Fuses
  - — Circuit breakers

— GFCI circuit breakers

NOTE: 120 volt circuits use a single fuse or circuit breaker. 240 volt circuits, such as those used by most central air units, require the use of two breakers.

- Branch circuits

  — Provide AC to outlets, appliances, lighting, etc. The size of the branch cable is based on the current or amperage required.

  EXAMPLE: A 15 amp. branch may use 12 AWG cable, while a 30 amp. circuit requires a 10 AWG cable.

- Device

  — Devices consist of receptacles, switches, etc.

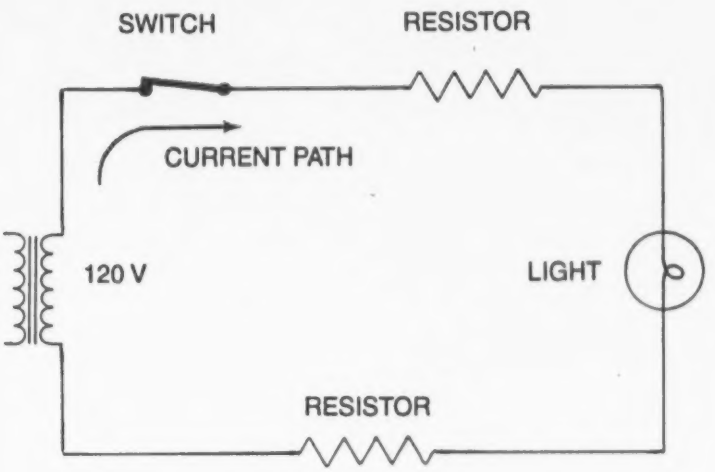
OBJECTIVE 4

Complete statements that define the rules for simple series and parallel circuits.

- Series circuit

  — A series circuit is one in which all the current flows through every part of the circuit. (Figure 5)

FIGURE 5



— Rules

A. The sum of the voltages measured across the individual components equals the voltage applied to the entire circuit.

B. The largest voltage drop occurs in the component with the highest resistance.

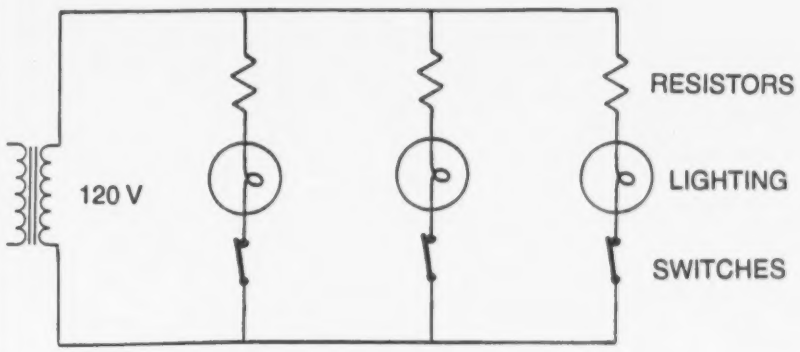
C. The sum of the resistance of the components equals the total resistance.

D. Current is the same through all components of a series circuit.

- Parallel circuit

  — A parallel circuit is one in which current flow is divided into two or more branch paths. (Figure 6)

FIGURE 6



CIRCUIT HAS BRANCH PATHS

  — Rules

    A. Total current equals the sum of all currents of each branch.

    B. Voltage is the same across all branches.

OBJECTIVE 5

From a list, choose those steps required to provide equipment grounding to devices and equipment within a power distribution system.

NOTE: The equipment grounding system protects a person from electrical shock and equipment from damage. To do so, the equipment ground conductor must connect to all metal outlet boxes, switch boxes, receptacles, equipment frames, to the load center frame and to earth ground.

- Identifying equipment grounds terminals and conductors

  — All grounding terminals shall be green and hex-headed.

  — Metal devices will have grounding pigtails, lugs, or terminals.

  — Metal grounding clips may be used with some plastic boxes. There are limitations on the use of clips—refer to NEC and local electrical codes.

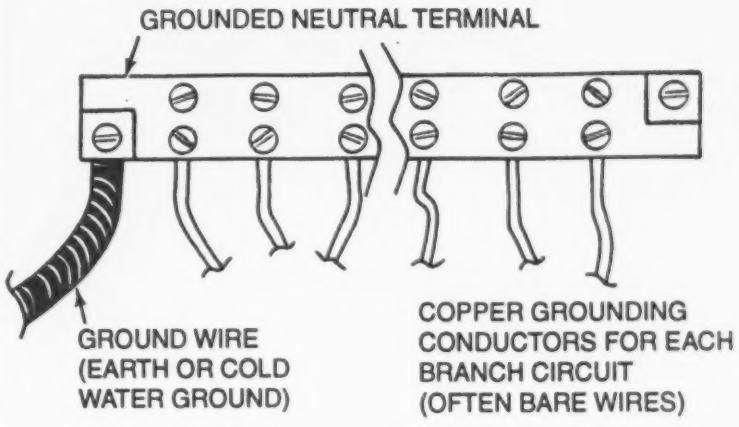
  NOTE: Requirements for terminal identification can be found in NEC manual.

- Steps necessary to provide equipment ground for typical AC distribution system

  — Load center

    A. Earth ground must be connected to the lug on the grounded neutral terminal inside the load center. (Figure 7)

FIGURE 7



NOTE: NEC and local codes have very specific rules concerning the establishment to earth ground; be certain you comply with codes.

— General guidelines for devices

A. Group and solidly connect all grounding conductors.

B. Connection shall be made from the grounding conductors to a green hex head screw or other device to ground all metal boxes.

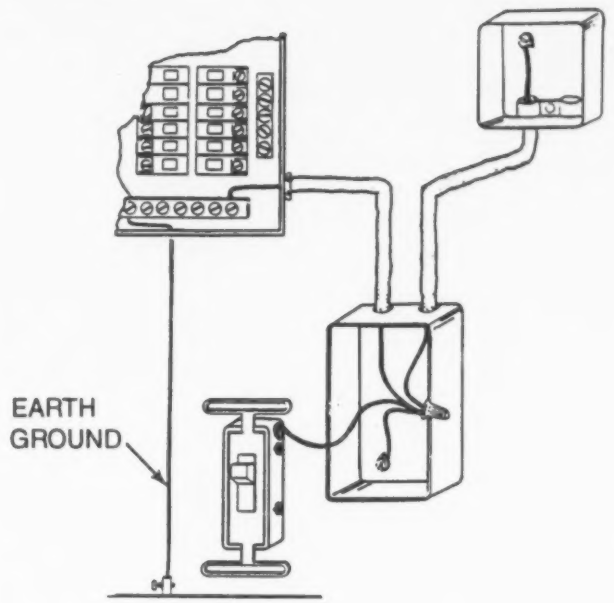
C. Grounding terminals on devices shall be connected to metal boxes by a bonding jumper.

NOTE: This connection shall be made in a manner that will allow for the removal of the device without breaking the continuity between the conductors and the box.

D. On surface boxes, the metal contact between the device and box shall serve as the grounding bond.

E. In plastic boxes, group the grounding conductors and connect them to the device grounding terminal, clip or use a wire nut as specified by local electrical code.

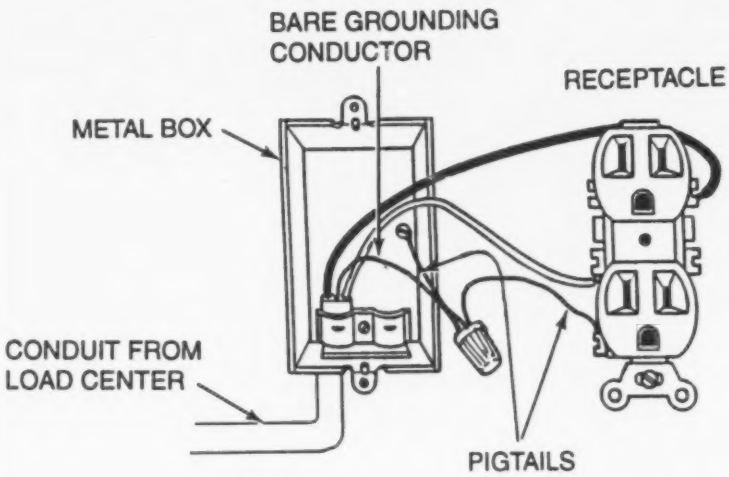
FIGURE 8



NOTE: For clarity, only the ground conductors are shown. Some load centers have a single neutral grounding terminal while others have two terminals.

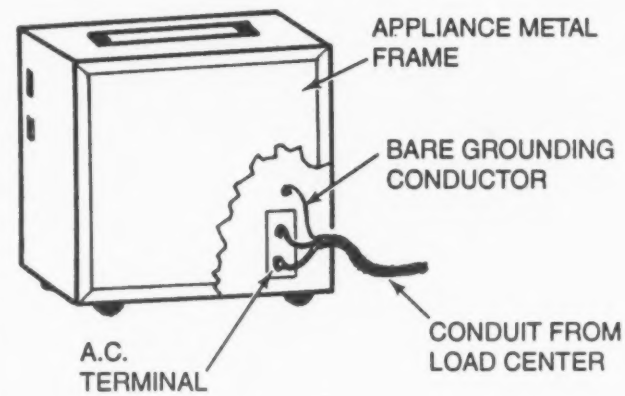
— Grounding receptacles

FIGURE 9



— Grounding appliances

FIGURE 10



OBJECTIVE 6

Select the correct methods to wire electrical receptacles, switches, and lighting.

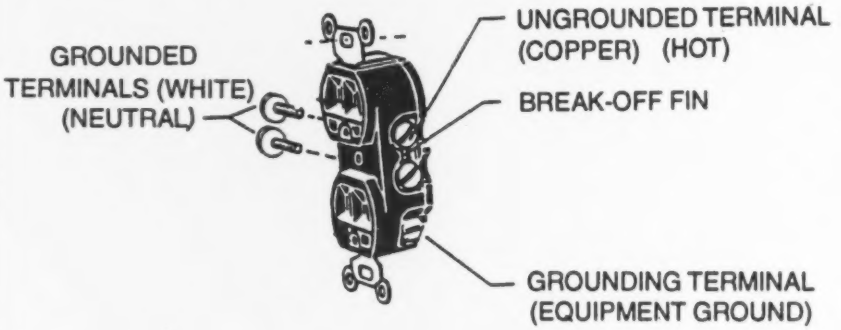
- 120V electrical receptacles

  — White (neutral) conductors are connected to neutral bar within the load center and to the white colored terminal of the receptacle. (Figure 11)

  NOTE: For 240V circuits, the white conductor is attached to a second circuit breaker inside the load center.

  — Black (hot) conductors are connected to one side of the circuit breaker or fuse within the load center and to the copper colored terminal of the receptacle. (Figure 11)

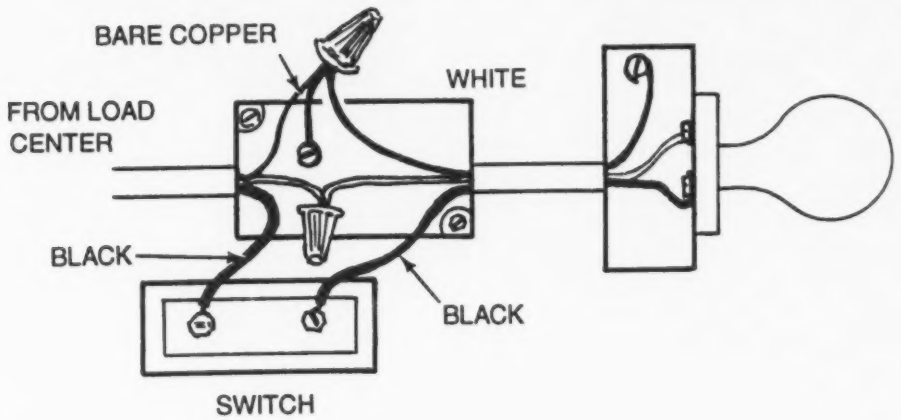
FIGURE 11



- Switches

  — The figure shown is a singlepole switch used with a lighting outlet. Notice that only the black (hot) conductor connects to the switch. The white (neutral) conductor is electrically unbroken. (Figure 12)

FIGURE 12



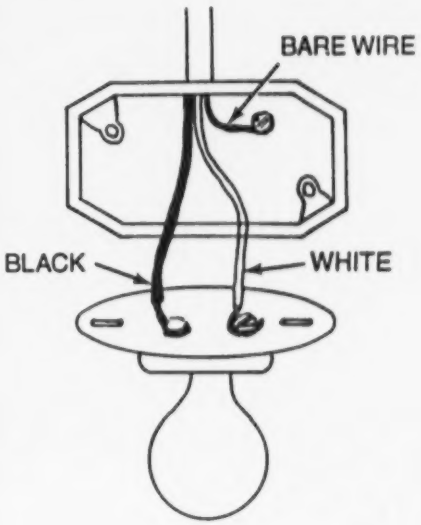
  — Normally the white (neutral) conductor is never attached to a switch or broken in any way. Exceptions are seldom allowed and are provided in the NEC electrical code manual.

- Lighting

  — There are many types of lighting and each has electrical wiring requirements. Be sure to read the manufacturer's instructions before installation.

— A simplified connection is shown below. (Figure 13)

FIGURE 13



- Wire nuts

  — Wire nuts have threaded metal interiors and are covered with insulating material. To use—twist together the stripped wires in a clockwise direction. Then, in the same direction, tightly screw on the wire nut. Ensure no bare wire is exposed at the open end of the wire nut.

- Cable clamping

  — Cable clamping is required by NEC and local codes. These requirements include stapling cables during routing and clamps inside boxes that are used in an AC distribution system.

  — Summary

    A. In 120V applications, the neutral and earth grounds are connected at the load center.

B. The white (neutral) is continuous, not broken, within each circuit. Each branch circuit should have a continuous white wire from the load center to the last device on that branch.

C. The black (hot) wire is connected to the circuit breaker within the load center.

OBJECTIVE 7

Match electrical schematic symbols to their titles. (Assignment Sheet)

- Schematic symbols
  - — Schematic symbols are shown on drawings to identify components of an electrical system and graphically portray the way in which each is to be installed.
- Symbol table

TABLE 2

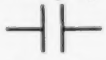
Name	Symbol
Transformer	
Contact	Normally open  Normally closed
Fuse	

TABLE 2 (continued)

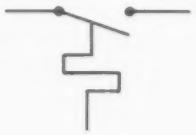
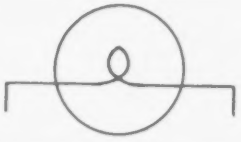
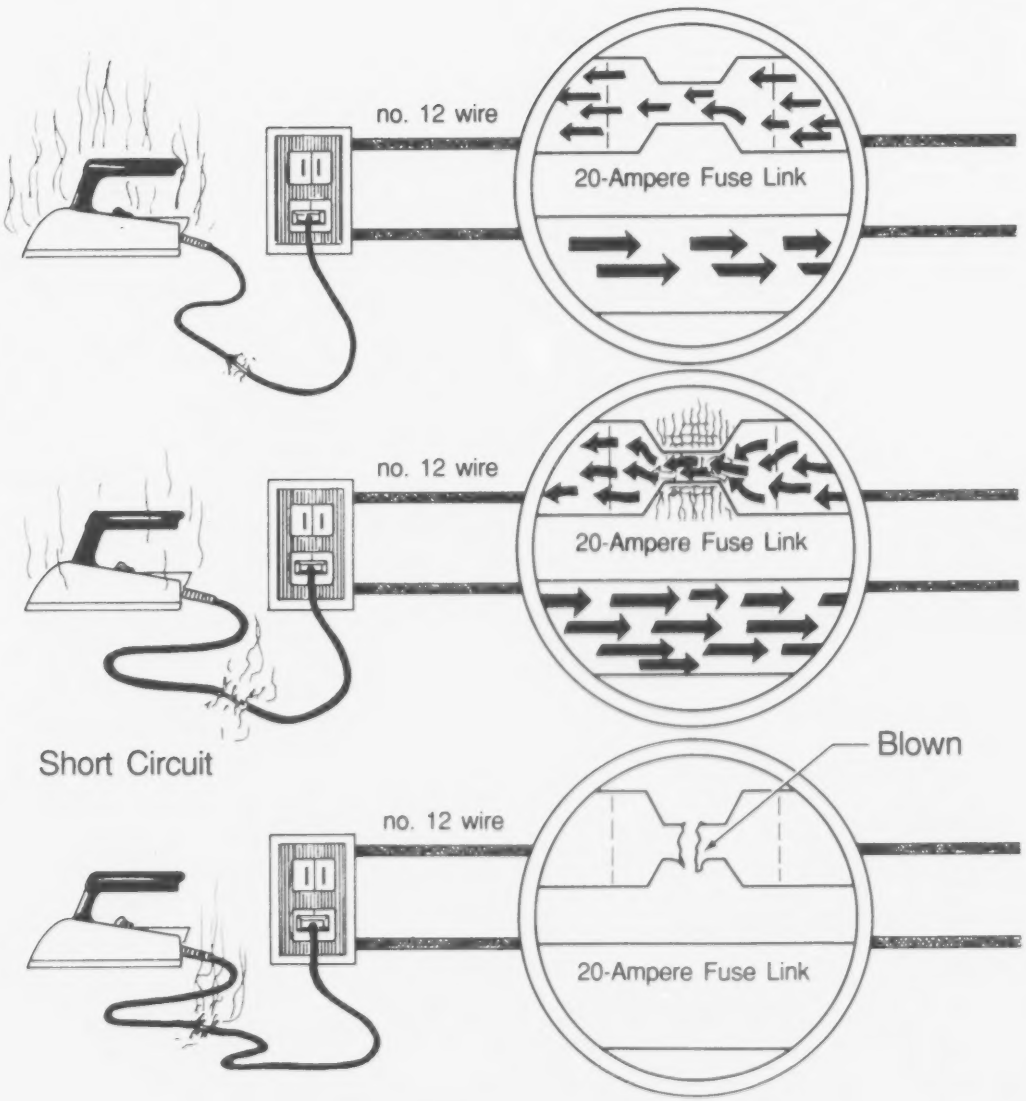
Name	Symbol
Ground connection	
Single pole switch	
Three-way switch	
Four-way switch	
Thermostat	
Wire crossover (not connected)	

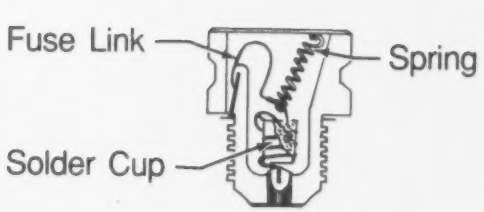
TABLE 2 (continued)

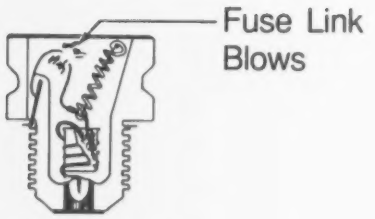
Name	Symbol
Wire (connected)	
Light fixture	
Single phase motor	

How a Fuse Works

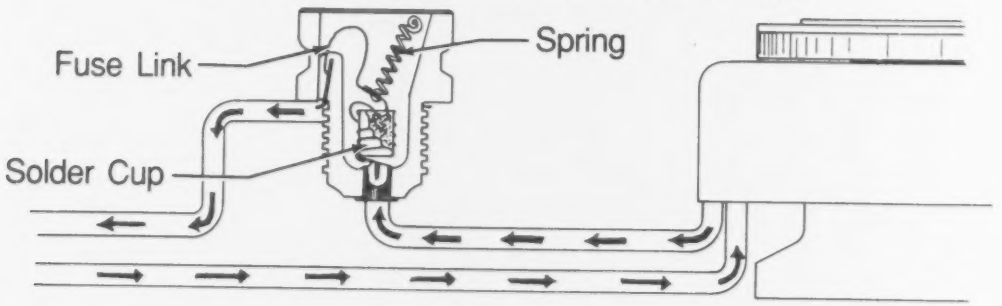


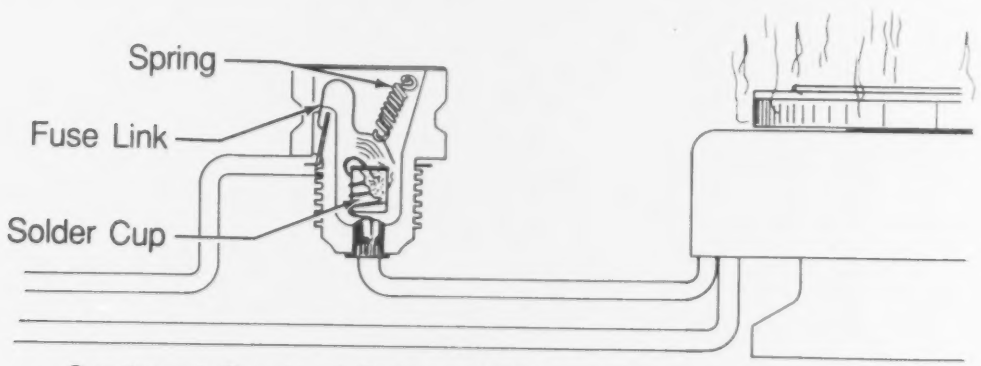
How a Time Delay Fuse Works





Temporary Overload Causes Solder to Heat





Continued Overload Softens Solder - Spring Pulls Fuse Link

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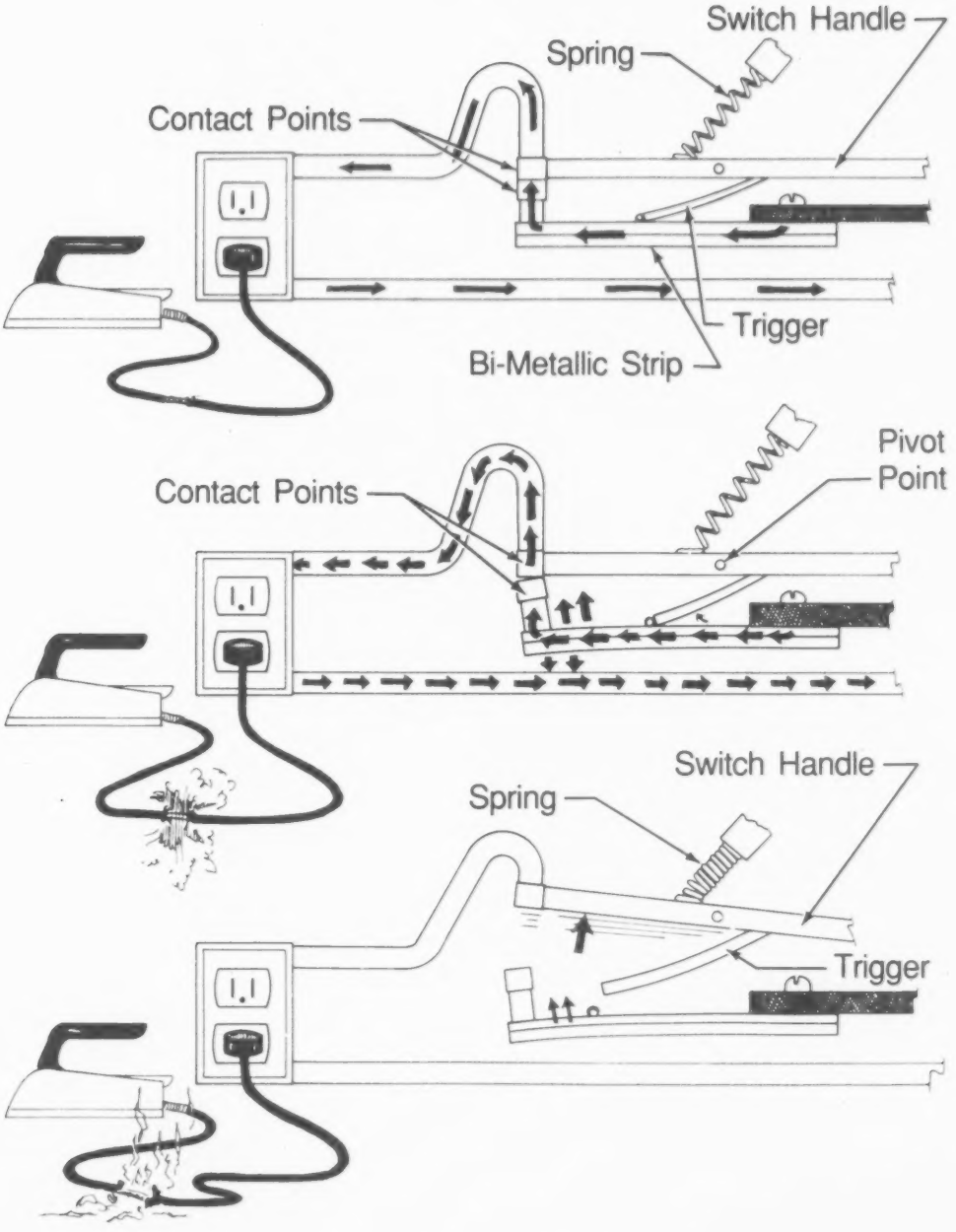
How a Circuit Breaker Works



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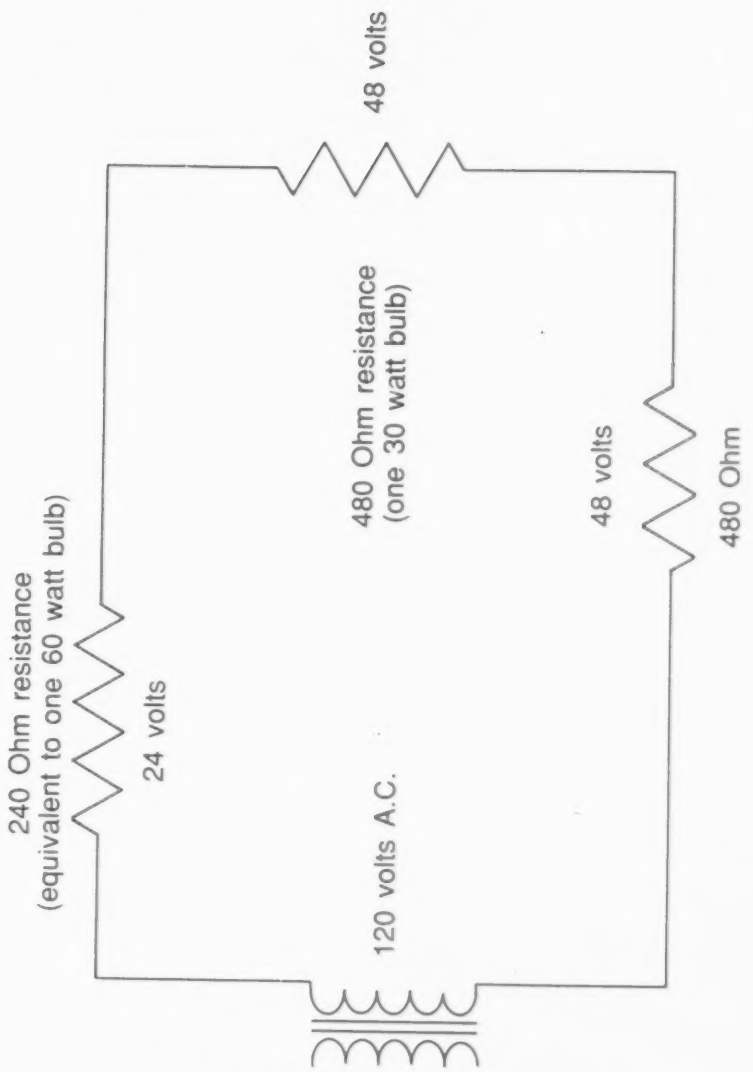
Series Circuit Rules



Total volts = 24 + 48 + 48
Highest resistance has highest voltage drop
Total Ohms = 240 + 480 + 480
Total current = 120/1200

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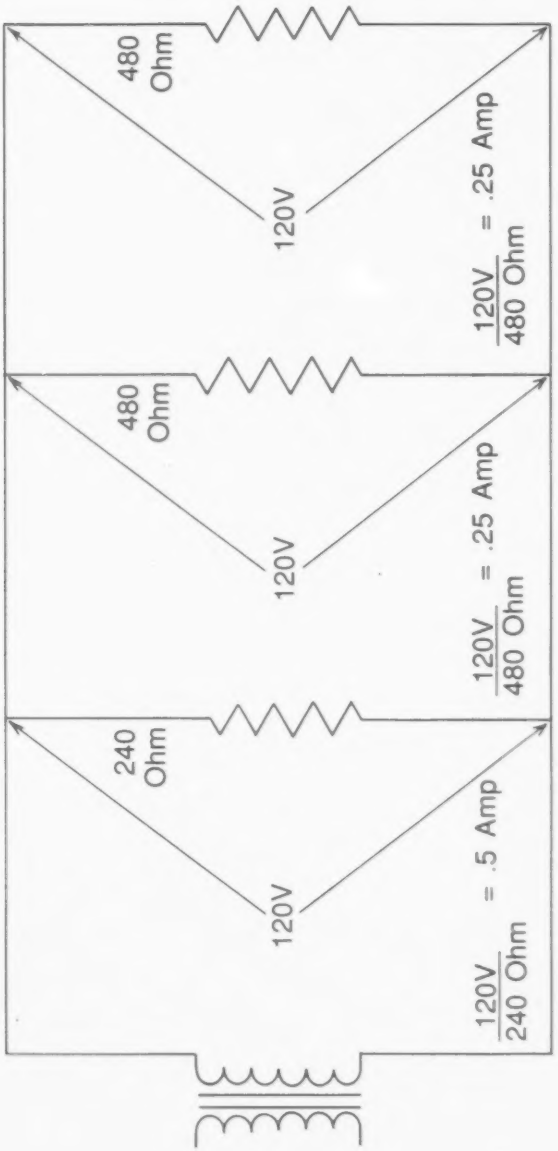
Rules for Parallel Circuits



Total current = .5 + .25 + .25 = 1 amp
Voltage is equal across all branches
Total resistance = less than branches
120V/1 Amp = 120 Ohms
Total power = 60 + 30 + 30 = 120 watts

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ASSIGNMENT SHEET	APPLIED SKILLS	A 3

Name _____ Score _____

OBJECTIVE 7

Match electrical schematic symbols to their titles.

INTRODUCTION

Electrical schematic symbols are used to convey the requirements of an AC distribution system.

INSTRUCTIONS

In the space provided, write the title of each symbol.

Functional Reading
- Interpret graphics and symbols

Fuse	**Wire crossover**	**Transformer**
Single phase motor	**Single pole switch**	**Light fixture**
Three-way switch	**Ground connection**	**Thermostat**
Wire connected	**Four-way switch**	**Contact**

1. _____

2. _____

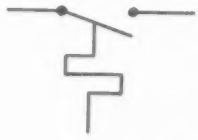
3. _____

4. _____

5. _____

6. _____

7. _____

8.  _____

9. _____

10. _____

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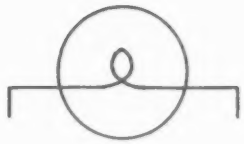
11. 

12.

ASSIGNMENT SHEET

1. Transformer
2. Contact
3. Ground connection
4. Fuse
5. Single pole switch
6. Three-way switch
7. Four-way switch
8. Thermostat
9. Wire crossover
10. Wire connected
11. Light fixture
12. Single phase motor

JOB SHEET 1	APPLIED SKILLS	A 3

NAME _____ SCORE _____

OBJECTIVE 8

Install a duplex grounding type receptacle and a plate.

INTRODUCTION

This exercise will allow you to practice developing skills to run cable, bore holes for cables, connect branch circuits, and install the receptacle and plate.

TOOLS AND EQUIPMENT

- Hard hat and goggles
- Side cutters
- Long nose pliers
- Standard knife
- Pocket knife
- Wire strippers
- Electrician's hammer
- 12 or 14 AWG NM cable
- Device box
- Load center
- Electrical supply
- Staples
- ⅜" cable connector
- Extension cord
- Duplex grounding type receptacle
- Neon test light or voltmeter
- Stud wall or work board
- Tool pouch
- Steel tape
- Drill
- ½" or larger wood bit

PROCEDURE

Functional Reading
- Follow written instructions
- Interpret graphics and symbols

Math Application
- Use English and metric measures

Functional Math
- Make measurements

Physical Science
- Investigate/apply physical laws

Job Acquisition/ Development
- Master specific job task/procedure
- Practice good work habits/attitudes

		Yes	No
1.	Put on safety equipment.	___	___
2.	Mount box on stud.	___	___
	NOTE: Remember that box set-out depends on the thickness of the wall covering to be installed.		
3.	Remove a half-inch knockout from the panel of the box.	___	___
	NOTE: Side cutting pliers may be needed to finish removing the raised knockout.		
4.	Install cable connector inside box.	___	___
5.	Bore holes in studs for cable.	___	___
	NOTE: Holes must be drilled no less than 1¼″ inward from the outside. Holes should be drilled at least 6 inches above or below the box depending on which route is the closest.		

CAUTION: Be sure and hold the drill securely. A loose grip can cause an accident.

6.	Run cable.	___	___
	NOTE: Leave at least 8″ extending past the surface of device box and enough to reach the top of the load center plus half the width of the box.		
7.	Staple cable within 12″ of metal boxes, 8″ of nonmetallic boxes.	___	___

	Yes	No
8. Secure all cable clamps and connectors.	___	___

CAUTION: Tighten clamps until the cable will not slip in the box; overtightening can cause an electrical short.

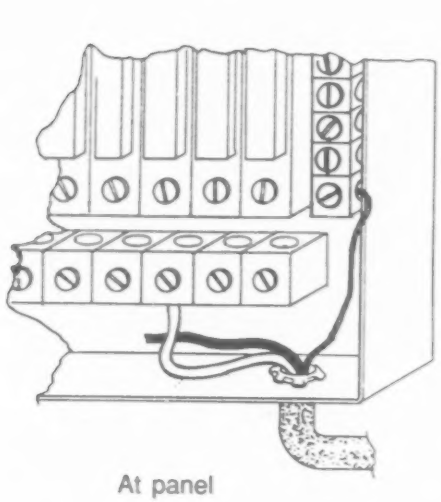
9. Strip cable insulation at device box and load center.	___	___

NOTE: Trim the cable sheating to within ¼" of its point of entry.

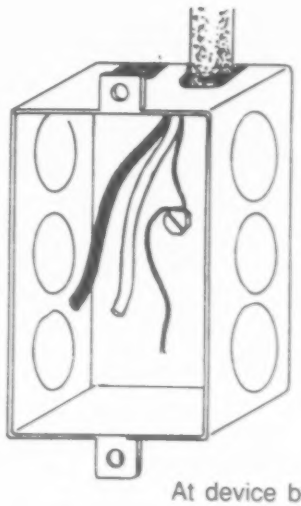
CAUTION: Extreme care should always be used in operations involving a knife; a cut hand can cause pain and lost work time.

10. Ensure main breaker of load center is turned off.	___	___
11. Connect equipment grounding conductors and circuit neutral. (Figure 14)	___	___

FIGURE 14



At panel



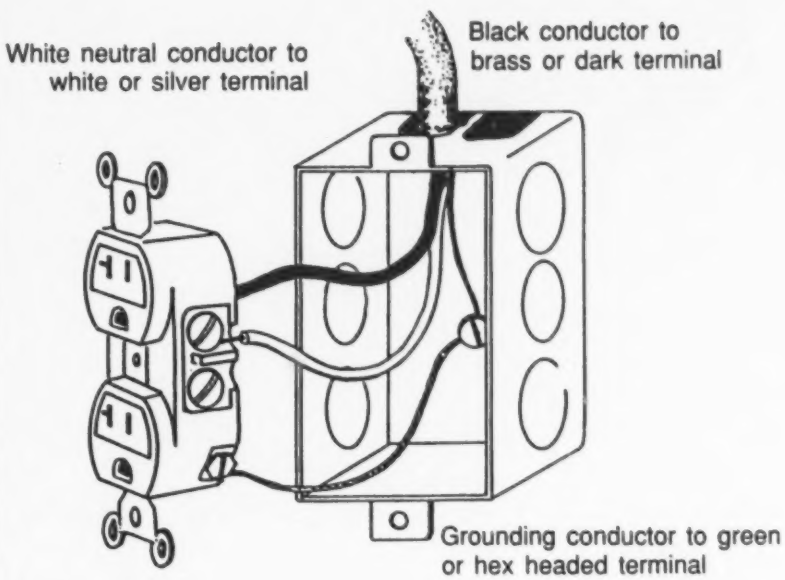
At device box

Yes No

NOTE: In a residence, all circuit neutrals and equipment grounding conductors would be connected at one time; the procedure is called panel make-up. On some load centers, the neutral and equipment terminals are one single terminal rather than two separate terminals as shown here.

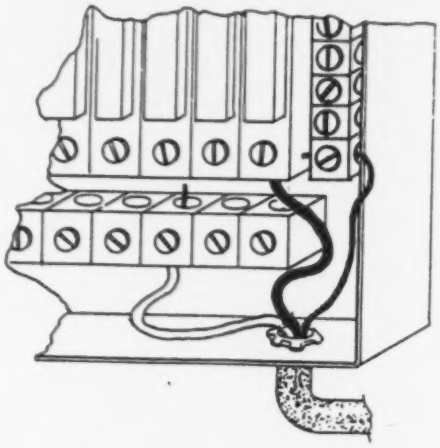
12. Install receptacle. (Figure 15) ___ ___

FIGURE 15


White neutral conductor to white or silver terminal
Black conductor to brass or dark terminal
Grounding conductor to green or hex headed terminal

	Yes	No
13. Double check—be sure the breaker is off or the fuse is out before connecting conductors. Always be safety conscious.	___	___
13. Connect ungrounded (black) conductor to appropriate overcurrent device. (Figure 16)	___	___

FIGURE 16



15. Turn breaker on or screw fuse in at load center.	___	___

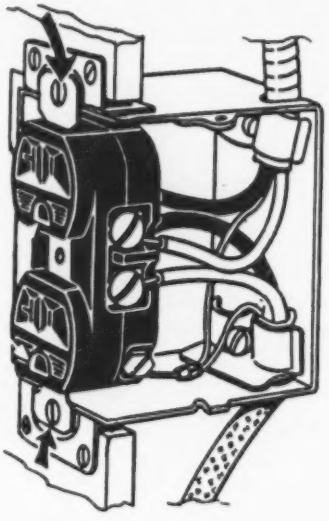
CAUTION: Stand to the side of the panel when turning on the breaker. A short circuit could cause molten metal to fly from the panel.

16. Test receptacle with neon test light or voltmeter.	___	___

	Yes	No
17. Have instructor evaluate this project.	___	___
18. Turn off breaker.	___	___
19. Square up the device or devices. (Figure 17)	___	___

NOTE: The slots for the device securing screws are elongated to allow straightening of the device even if the box is not straight.

FIGURE 17



20. Install plate.	___	___

NOTE: Be careful not to overtighten and crack the plate.

21. Clean work area and store tools properly.	___	___

(End of Job Sheet)

SKILL TEST RECORD

EVALUATOR'S COMMENTS

_____

_____

_____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

All NEC and local electrical codes followed	4	3	2	1
Connections made correctly	4	3	2	1
Connections tight at panel	4	3	2	1
Properly used neon light or voltmeter	4	3	2	1

EVALUATOR'S COMMENTS

_____

_____

_____

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 **Skilled** — Can perform job with no additional training

3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required

2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill

1 **Unskilled** — Is familiar with process, but is unable to perform job

JOB SHEET 2	APPLIED SKILLS	A 3

NAME _____ SCORE _____

OBJECTIVE 9

Wire a single pole switch and light.

INTRODUCTION

This job sheet describes the procedures to wire a single pole switch and light into a load center.

TOOLS AND EQUIPMENT

- Hard hat and goggles
- 12 or 14 AWG NM cable
- Device box
- Octagon box

NOTE: Be sure your boxes have an NEC capacity rating to accommodate the conductors you will install.

- Staples
- Single pole switch
- Light socket
- Bar hanger

NOTE: If a bracket octagon box is used or if this job is installed on a work board, a bar hanger will not be needed.

- Stud wall
- ⅜" cable clamp
- 120v incandescent bulb
- Wire connectors
- Two 16 penny nails
- 2 drywall nails
- Electrician's hammer
- Long nose pliers
- Pocket knife
- Wire strippers
- Tool pouch
- Drill
- ½" or larger wood bit

- Steel tape
- Extension cord
- Standard screwdriver

PROCEDURE

Yes No

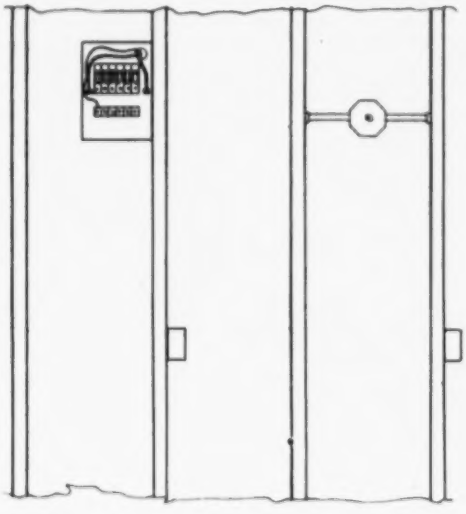
Functional Reading
- Follow written instructions
- Interpret graphics and symbols

1. Put on safety equipment. ___ ___

2. Mount boxes. (Figure 18) ___ ___

   NOTE: Switch box and ceiling outlet can be mounted at any height in this project.

FIGURE 18



Math Application
- Use English and metric measures

Functional Math
- Make measurements

Physical Science
- Investigate/apply physical laws

Job Acquisition/ Development
- Master specific job task/procedure
- Practice good work habits/attitudes

3. Remove half-inch knockout from the panels of each box. ___ ___

4. Install cable connector in both boxes. ___ ___

Yes No

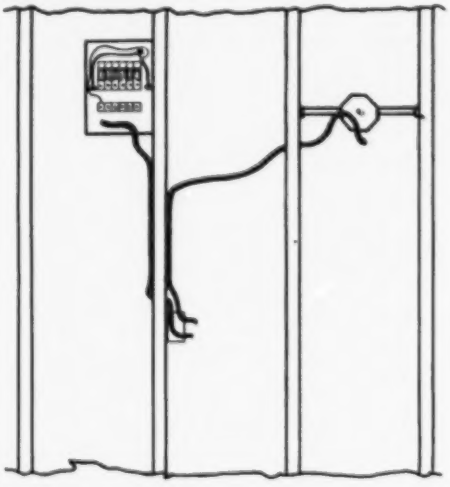
5. Bore holes in studs for cables. ___ ___

NOTE: Holes must be drilled no less than 1¼" inward from the outside of a stud. Holes should be drilled at least 6 inches above or below box depending on which route is the closest.

CAUTION: Be sure and hold the drill securely. A loose grip can cause an accident.

6. Run cable between boxes. (Figure 19) ___ ___

FIGURE 19



NOTE: Leave at least 8" extending past the surface of your device and lighting outlet boxes and enough to reach the top of the load center plus ½ of the width of the box.

	Yes	No
7. Staple cable within 12″ of all metal boxes, 8″ of all nonmetallic boxes. **NOTE:** Cables should be run flat when possible.	___	___
8. Secure all cable clamps and connectors.	___	___

CAUTION: Tighten clamps until the cable will not slip in the box; overtightening can cause an electrical short.

9. Strip cable insulation. (Figure 20)	___	___

NOTE: Cables could be stripped before they are installed in the boxes.

FIGURE 20

NOTE: Trim the cable covering to within ¼″ of its point of entry.

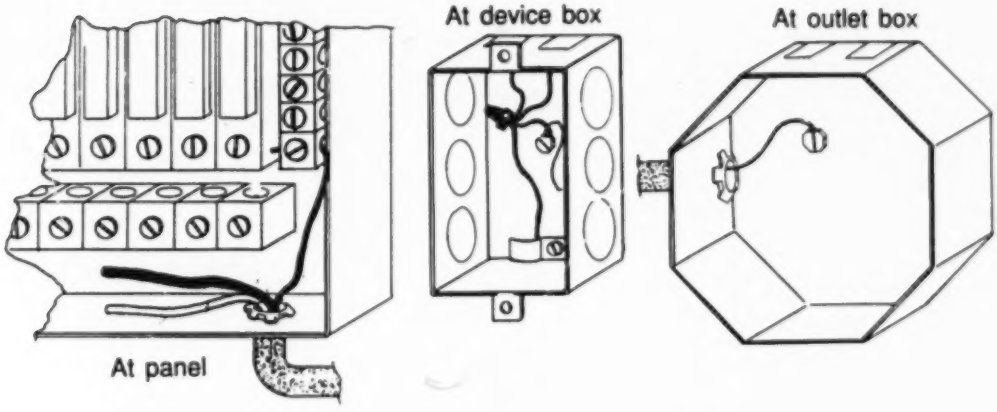
Yes No

CAUTION: Extreme care should always be used in operations involving a knife; a cut hand can cause pain and lost work time.

10. Be sure the breaker is off or the fuse is out before connecting conductors. Always be safety conscious when working inside the load center. — —

11. Connect all grounding conductors (green or bare) (Figure 21) — —

FIGURE 21

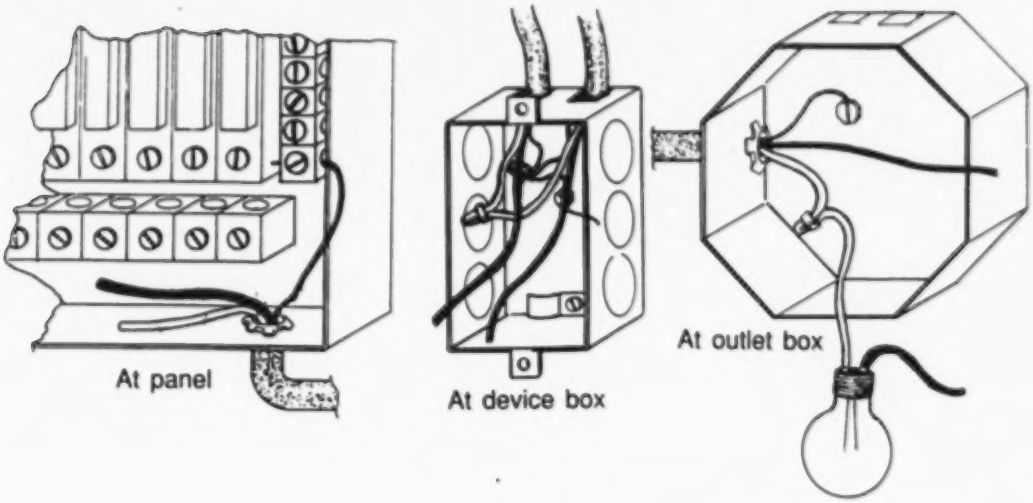


NOTE: Always leave enough conductor to make removal and connection easy. Notice extra bend at load center.

Yes No

12. Connect all neutral conductors (white) (Figure 22) — —

FIGURE 22

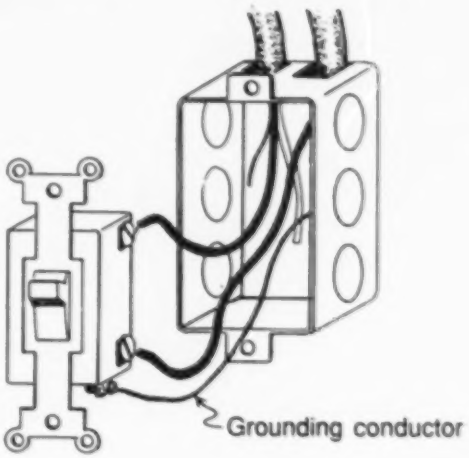


13. Connect return leg (black wire) to lampholder at outlet box. — —

Yes No

14. Connect switch (black wires). (Figure 23) ___ ___

FIGURE 23



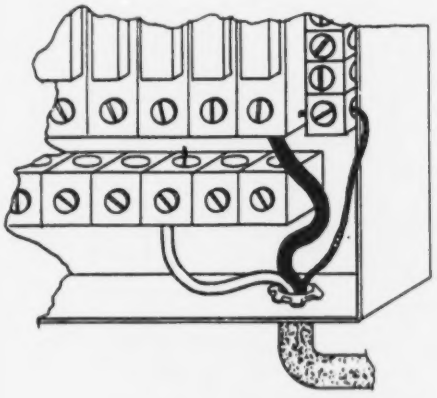
NOTE: Be sure that the loop in the conductors is turned in the direction that the terminal tightens (clockwise).

15. Install the switch box. ___ ___

NOTE: Be sure to push all conductors into the box; don't rely on the installation of the switch to situate them.

	Yes	No
16. Connect ungrounded conductor (black) to appropriate overcurrent device. (Figure 24)	___	___

FIGURE 24



17. Put single pole in OFF position.	___	___
18. Turn breaker on.	___	___

CAUTION: Stand to the side of the panel when turning on the breaker. A short in the circuit could cause molten metal to fly from the panel..

19. Turn on the switch to illuminate the lamp.	___	___
20. Have your instructor evaluate this project.	___	___
21. Turn off breaker.	___	___

	Yes	No
22. Clean work area and store tools properly.	___	___

(End of Job Sheet)

SKILL TEST RECORD

EVALUATOR'S COMMENTS

_____

_____

_____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
All NEC and local electrical codes followed	4	3	2	1
Connections tight at panel	4	3	2	1
Safety procedures followed	4	3	2	1
Lamp illuminated	4	3	2	1

EVALUATOR'S COMMENTS

_____

_____

_____

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 **Skilled** — Can perform job with no additional training

3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required

2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill

1 **Unskilled** — Is familiar with process, but is unable to perform job

JOB SHEET 3	APPLIED SKILLS	A 3

NAME _____ SCORE _____

OBJECTIVE 10

Wire a receptacle fed from a lighting outlet through a single pole switch.

INTRODUCTION

This exercise allows you to practice wiring multiple devices into a load center.

TOOLS AND EQUIPMENT

- Hard hat and goggles
- Wire connectors
- Four 16 penny nails or other fasteners as needed to secure the boxes
- Electrician's hammer
- Standard screwdriver
- Side cutting pliers
- Long nose pliers
- Pocket knife
- Wire strippers
- Tool pouch
- Drill
- 12 or 14 AWG NM cable
- Two device boxes
- Octagon box and bar hanger
- Light socket
- 120 volt bulb
- Staples
- Single pole switch
- Duplex grounding type receptacle
- Stud wall
- ½" wood bit
- Extension cord
- Load center
- Steel tape

PROCEDURE

Functional Reading
- Follow written instructions
- Interpret graphics and symbols

Math Application
- Use English and metric measures

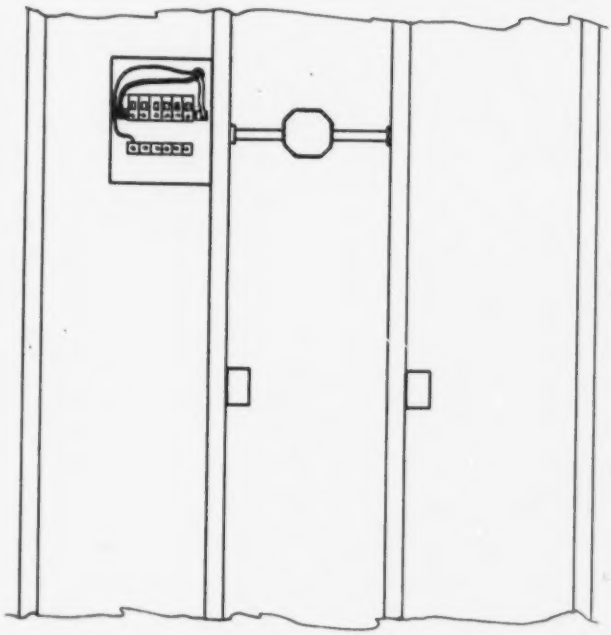
Functional Math
- Make measurements

Physical Science
- Investigate/apply physical laws

Job Acquisition/ Development
- Master specific job task/procedure
- Practice good work habits/attitudes

	Yes	No
1. Put on safety equipment.	___	___
2. Mount boxes. (Figure 25)	___	___

FIGURE 25



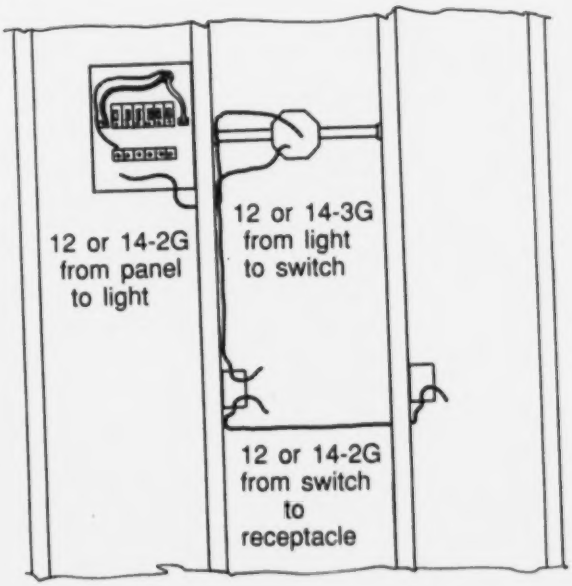
3. Remove a half-inch knockout from the panel of each box.	___	___
4. Install cable connector in each box.	___	___

	Yes	No
5. Bore holes through studs for cables.	___	___

NOTE: Holes must be drilled no less than 1¼" inward from the outside of a stud. Holes should be drilled at least 6 inches above or below the box depending on which route is the closest.

6. Run cable between boxes and to load center. (Figure 26)	___	___

FIGURE 26



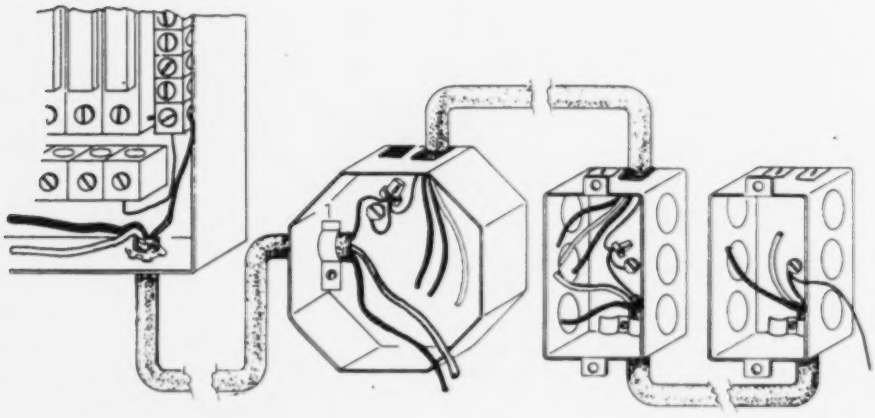
NOTE: Leave at least 8" extending past the surface of device boxes and enough to reach the top of load center plus half the width.

	Yes	No
7. Staple cable within 12″ of metal boxes, 8″ of nonmetallic boxes.	___	___
8. Secure all cable clamps and connectors.	___	___

CAUTION: Tighten clamps until the cable will not slip in the box; overtightening can cause an electrical short.

9. Strip cable insulation at device box and panel.	___	___
10. Connect equipment grounding conductors. (Figure 27)	___	___

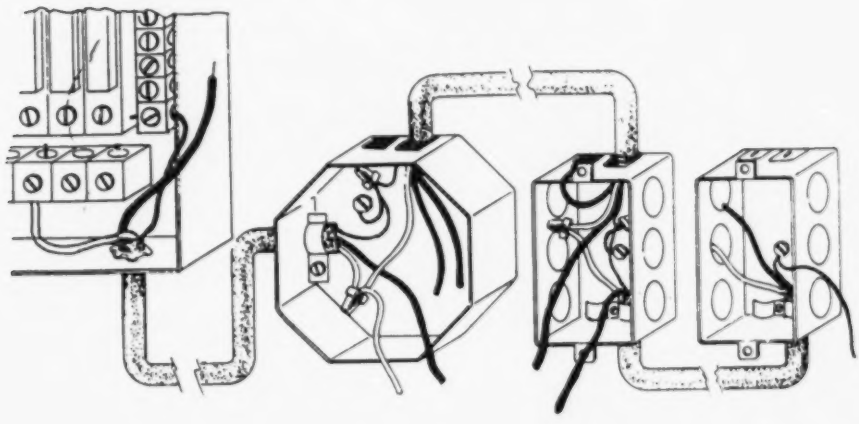
FIGURE 27



Yes No

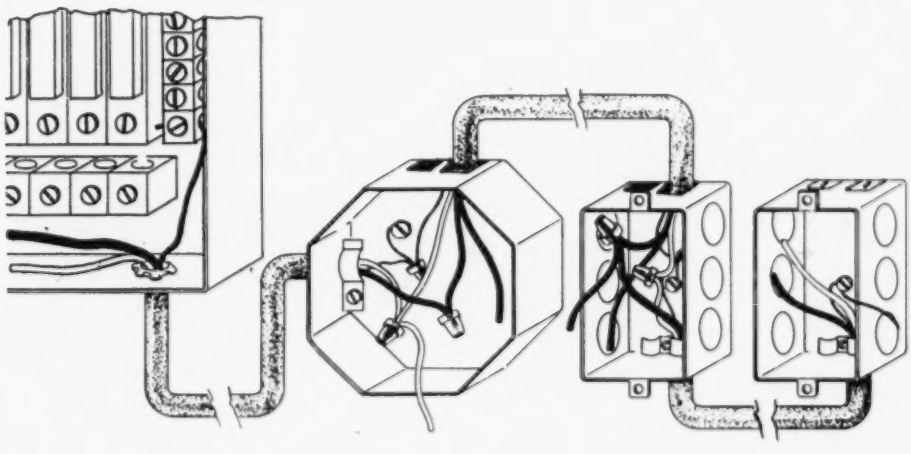
11. Make up neutral (white wires) through the system. (Figure 28) — —

FIGURE 28



12. Make up switch, return, and feed through conductors (black wires). (Figure 29) — —

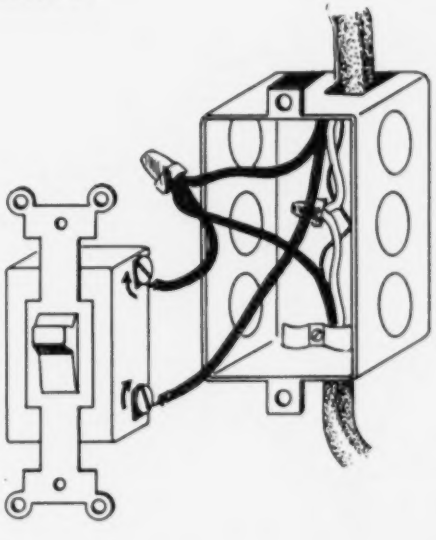
FIGURE 29



Yes No

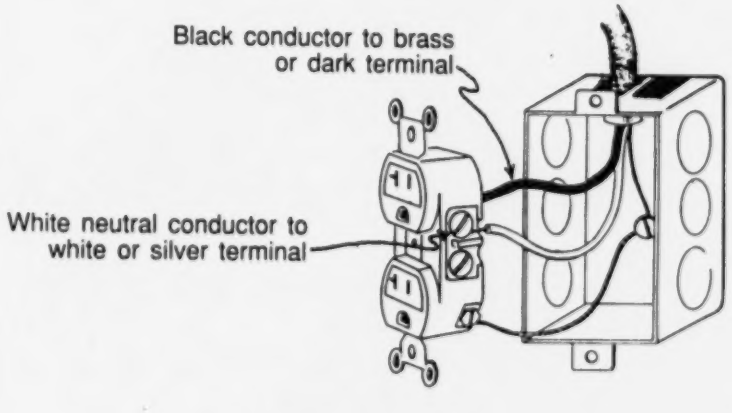
13. Install switch. (Figure 30) ___ ___

FIGURE 30



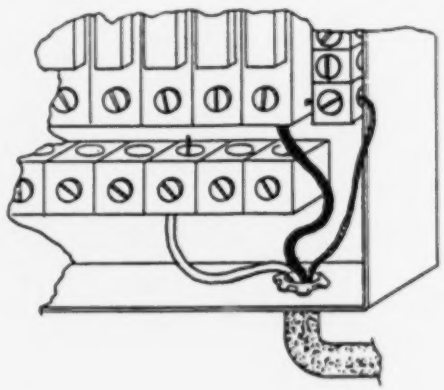
14. Install receptacle. (Figure 31) ___ ___

FIGURE 31



	Yes	No
15. Connect return leg (black) and neutral (white) to light socket.	___	___
16. Be sure the breaker is off or the fuse is out before connecting any conductors inside the load center. Always be safety conscious.	___	___
17. Connect ungrounded (black) conductor to overcurrent device. (Figure 32)	___	___

FIGURE 32



18. Turn on breaker or screw in fuse.	___	___
19. Turn on switch.	___	___
NOTE: Light should illuminate.		
20. Test receptacle with neon test light or voltmeter.	___	___

	Yes	No
21. Have your instructor inspect this project.	___	___
22. Turn off breakers.	___	___
23. Clean work area and store tools properly.	___	___

(End of Job Sheet)

SKILL TEST RECORD

EVALUATOR'S COMMENTS

_____

_____

_____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
All NEC and local electrical codes followed	4	3	2	1
Cable connections tight in panel and devices	4	3	2	1
Light illuminated	4	3	2	1
Neon test light or voltmeter used properly	4	3	2	1

EVALUATOR'S COMMENTS

_____

_____

_____

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 **Skilled** — Can perform job with no additional training
3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required
2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill
1 **Unskilled** — Is familiar with process, but is unable to perform job

WRITTEN TEST	APPLIED SKILLS	A 3

Name _____ Score _____

OBJECTIVE 1

Given a list of terms associated with electrical skills, match them to their correct definitions. Write the letter that corresponds to the most correct answer.

_____ 1. Metal tabs at the top and bottom of devices so they can be secured to boxes are called

a. anchors
b. terminals
c. straps or yokes
d. cable clamps

_____ 2. Wiring that leads from the load center and connects AC to devices and household appliances is a

a. branch circuit
b. service drop
c. service lateral
d. drop-in circuit

_____ 3. The white connector that often designates the neutral wire is also called the

a. equipment ground
b. hot conductor
c. ungrounded conductor
d. grounded conductor

_____ 4. A complete path for current to flow from the source through the load and back to the source is a

a. circuit
b. service lateral
c. traveler
d. service line

May be photocopied for student use.

votech

_____ 5. The conductor that carries electrical energy from the switch to the load is known as the

a. pole leg
b. return leg or switch
c. load leg
d. loop circuit

_____ 6. A unit of an electrical system which is intended to carry but not utilize electrical energy is a/an

a. appliance
b. device
c. raceway
d. hertz

_____ 7. The point of electrical attachment for conductors is called a

a. clamp
b. pole tap
c. terminal
d. service link

_____ 8. A piece of equipment used to secure cables is a

a. terminal
b. service point
c. pole bar
d. cable clamp

_____ 9. Electrical circuits with all loads installed in a single path are

a. series circuits
b. parallel circuits
c. marginal links
d. pathway circuits

May be photocopied for student use.

_____10. Written articles which provide minimum standards for safe electrical installations are known as

a. Northern Electricity Laws
b. National Engineering Committee
c. National Electrical Codes
d. OSHA codes

_____11. The underground conductors between the street main to a facility's service entrance are called the

a. service raceway
b. poles
c. service lateral
d. branch circuit

_____12. The black conductor often designated as the "HOT" wire is also known as the

a. grounded conductor
b. ungrounded conductor
c. equipment ground
d. electrode side

_____13. A unit of frequency equal to one cycle per second is a/an

a. amp (A)
b. volt
c. double cycle (DC)
d. hertz (Hz)

_____14. An electrical circuit with all loads installed across circuit conductors is a

a. parallel circuit
b. series circuit
c. cross "T" circuit
d. service pathway

May be photocopied for student use.

_____15. The conduit that encloses the service entrance conductors is a/an

a. panel enclosure
b. service drops
c. service lateral
d. service raceway

_____16. The current carrying conductors on a receptacle are called the

a. taps
b. slugs
c. poles
d. leads

OBJECTIVE 2

Given incomplete statements, choose the words that correctly complete electricity safety guidelines.

_____ 1. Be sure all connections are secure and _____ _____.

a. well insulated
b. tape wrapped
c. tied up
d. loosely tied

_____ 2. Watch out for _____ _____; they can cause bad burns.

a. threshold amperage
b. equipment grounds
c. electrical arcs
d. convulsive movement

_____ 3. Never underestimate the danger of _____.

a. 120 VAC circuits
b. equipment grounds
c. underloading a circuit
d. touching an insulator

May be photocopied for student use.

_____ 4. Always meet or exceed _____ and _____ electrical code for minimum installation requirements.

a. manufacturer's, local
b. OSHA, local
c. NEC, OEA
d. NEC, local

_____ 5. Never install equipment that will _____ a circuit.

a. underload
b. overload
c. load
d. insulate

_____ 6. Electrical shock can be fatal with as little as _____ amps.

a. .005
b. .01
c. .012
d. .05

_____ 7. Even mild shocks can cause personal injuries due to

a. your reaction to them
b. arcs causing burns
c. breathing paralysis
d. eye sensitivity

_____ 8. Trip the breaker and _____ before servicing a circuit.

a. replace the breaker
b. remove the cover
c. lock the load center door
d. re-engage the breaker

May be photocopied for student use.

_____ 9. Never keep tools lying around _____ _____.

a. not attended
b. metal panels
c. live conductors
d. unattached cables

_____10. Never bypass a _____ or _____ _____.

a. switch, open receptacle
b. fuse, circuit breaker
c. fuse, switch box
d. circuit, overhead raceway

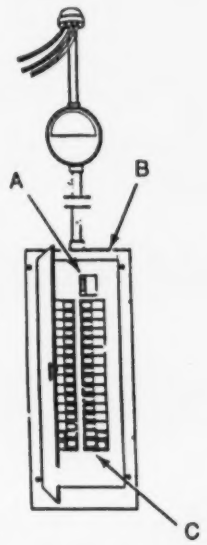
_____11. Always be sure that branch overcurrent protection is matched to your _____ _____.

a. switch device
b. box type
c. conductor rating
d. service entrance

May be photocopied for student use.

OBJECTIVE 3

Given a diagram, select the correct titles of major components of an AC power distribution system. Use the figure below to answer questions 1-3.



_____ 1. In the figure above, the component labeled as "A" is called a

a. branch circuit breaker
b. load center
c. main circuit breaker
d. service entrance

_____ 2. In the figure above, the components labeled as "C" are

a. branch circuit breakers
b. service entrances
c. main circuit breaker
d. meters

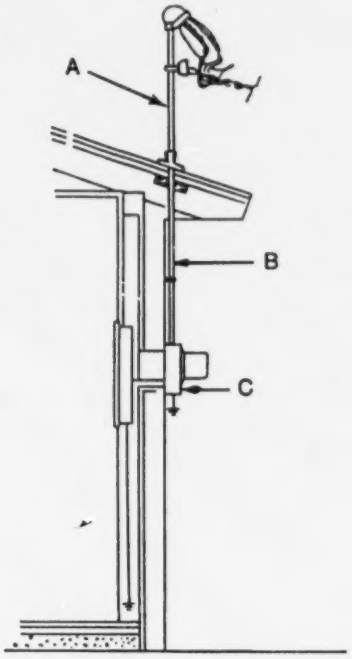
May be photocopied for student use.

_____ 3. The component labeled "B" in preceding figure is a

a. meter
b. load center
c. switch box
d. service entrance

INSTRUCTIONS

Use figure to respond to questions 4-6.



_____ 4. In preceding figure, the component identified with the letter "A" is a

a. service entrance raceway
b. meter
c. service mast
d. service-in conduit

May be photocopied for student use.

_____ 5. The component labeled as "B" in preceding figure is a

a. service-in conduit
b. roof saddle
c. service mast
d. service entrance raceway

_____ 6. The most common title of the component labeled "C" in preceding figure is a

a. meter base
b. load center
c. service mast
d. raceway

OBJECTIVE 4

Complete statements that define the rules for simple series and parallel circuits.

_____ 1. In a series circuit, the sum of the voltages measured across the individual components equals the voltage applied to the _____ _____.

a. entire circuit
b. partial circuit
c. third branch
d. first component

_____ 2. In a series circuit, the current is _____ _____ through all components of the circuit.

a. one-half
b. split evenly
c. the same
d. branched evenly

_____ 3. In parallel circuits, the total current _____ _____ _____ of all currents of each branch.

a. is one half
b. equals the sum
c. divides in thirds
d. is one fourth

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_____ 4. In parallel circuits, the _____ is the same across all branches.

a. current
b. amperage
c. resistance
d. voltage

OBJECTIVE 5

From a list, choose those steps required to provide equipment grounding to devices and equipment within a power distribution system.

_____ 1. Grounding terminals can be identified by

a. black color
b. white color
c. green color and square heads
d. green color and hex heads

_____ 2. Before using grounding clips with plastic boxes

a. consult NEC and local electrical codes
b. ground the plastic box with a pigtail
c. drill a small mounting hole through the box
d. always use at least two clips per box

_____ 3. Earth ground must be connected to the load centers

a. overcurrent protection device
b. meter outlet
c. grounded neutral terminal
d. main circuit breaker

_____ 4. To properly ground appliances

a. connect the bare grounding conductor to the appliance metal frame
b. connect the black and white conductors to the appliance's AC terminal
c. strap the appliance frame to the nearest insulator
d. use a 12 AWG wire from the appliance frame to the conduit

May be photocopied for student use.

OBJECTIVE 6

Select the correct methods to wire electrical receptacles, switches, and lighting.

_____ 1. To wire a receptacle, the white conductor should be

a. connected to the copper colored terminal
b. connected to the equipment ground terminal
c. pigtailed to the metal frame of the box
d. connected to the white colored terminal

_____ 2. At the load center, the black conductor supplying AC to a receptacle must be attached directly to

a. the neutral grounding terminal
b. one side of circuit breaker
c. to the equipment ground
d. one side of the main circuit breaker

_____ 3. At the receptacle, the black conductor connects to

a. the white terminal
b. the metal box frame
c. the copper colored terminal
d. strap or yoke

_____ 4. As a general rule, the white conductor

a. is never attached to a switch or broken in any way
b. is the "hot" conductor
c. is the equipment ground conductor
d. is attached to the frame of appliances

OBJECTIVES 7-10

Evaluated through the use of assignment and job sheets.

May be photocopied for student use.

WRITTEN TEST ANSWERS	APPLIED SKILLS	A 3

OBJECTIVE 1

1. c	9. a
2. a	10. c
3. d	11. c
4. a	12. b
5. b	13. d
6. b	14. a
7. c	15. d
8. d	16. c

OBJECTIVE 2

1. a	7. a
2. c	8. c
3. a	9. c
4. d	10. b
5. b	11. c
6. d	

OBJECTIVE 3

1. c	4. c
2. a	5. d
3. b	6. a

OBJECTIVE 4

1. a	3. b
2. c	4. d

OBJECTIVE 5

1. d	3. c
2. a	4. a

OBJECTIVE 6

1. d	3. c
2. b	4. a

OBJECTIVES 7-10

Evaluated through the completion of assignment and job sheets.

CIMC
TEST CODE SHEET

VOCATIONAL PROGRAM (BOOK TITLE) INTRODUCTION TO ELECTRICITY

UNIT NUMBER AND TITLE – A3 – APPLIED SKILLS

TOTAL NUMBER OF TEST QUESTIONS 45

TOTAL NUMBER OF BASIC SKILL QUESTIONS 26

OBJECTIVE NUMBER	TEST QUESTION NUMBER(S)	BASIC SKILL CODE(S)
1	1, 2, 7, 8, 10, 11, 15, 16	X
1	3, 4, 5, 6, 9, 12-14	S
2	1-11	X
3	1-6	S
4	1, 3	M, S
4	2-4	S
5	1-4	S
6	1-4	S
7-10	Evaluated on Assignment and Job Sheets	

INTRODUCTION TO ELECTRICITY
COMPETENCY PROFILE

Student _____ Soc. Sec. No. ___ — ___ — ____
Last First MI

PROGRAM Grade 9 10 11 12 Adult SCHOOL

INSTRUCTOR SCHOOL ADDRESS PHONE

STUDENT'S HOME ADDRESS DATE OF BIRTH PHONE

STUDENT'S EMPLOYER ADDRESS PHONE

CONTACT IN CASE OF EMERGENCY PHONE

ADDRESS

OR

ADDRESS PHONE

The above information can be used for school records and/or to ensure safety of students. This confidential information is not to be released to employers or to the general public.

ON-THE-JOB TRAINING/WORK EXPERIENCE

DURATION OF EMPLOYMENT	JOB TITLE	EMPLOYER	SUPERVISOR'S NAME	ADDRESS OF EMPLOYER	PHONE

This agency does not discriminate on the basis of race, creed, color, national origin, sex, age, veteran status, qualified handicap, or disability.

Duplicate one copy for each student.

SPECIFIC JOB COMPETENCIES

DIRECTIONS: Evaluate the trainee using the rating scale below, and check the appropriate number to indicate the degree of competency. The numerical ratings of 4, 3, 2, 1, and 0 are not intended to represent the traditional school grading system of A, B, C, D, and F. The descriptions associated with each of the numbers focus on level of student performance for each of the tasks listed below.

Rating Scale:
4 — **Skilled** — can perform job independently with no additional training.
3 — **Moderately Skilled** — has performed job independently during the training program; limited additional training may be required.
2 — **Limited Practice** — has practiced job during training program; additional training is required to develop skill.
1 — **Exposure Only** — general information provided with no practice time; close supervision needed and additional training required.
0 — **No Exposure** — no information or practice provided during training program; complete training required.

UNIT A1

4	3	2	1	0

Electrical Materials

1. Given a list of terms associated with electrical materials, match them to their correct definitions.
2. Identify types and sizes of electrical conductors.
3. Match conductor color codes to their names or purposes.
4. Given drawings, select from a list types of conduit, electrical boxes, covers, and plates used in construction.
5. Provide drawings, match the correct titles to electrical hardware such as fasteners, anchors, and connectors.
6. Provided drawings, match the correct titles to electrical receptacles, switches, low voltage components, and sockets.
7. Match drawings to the correct titles for switch enclosures, load centers, and other major electrical components.
8. _____

WRITTEN TEST SCORE _____

UNIT A2

4	3	2	1	0

Electrical Tools

1. Given a list of terms associated with electrical tools, match them to their correct definitions.
2. Complete statements concerning the safe use and care of electrical tools.
3. Given drawings, match them to the titles of electrical tools.
4. Adjust wire strippers.
5. Trim conductor insulation using a knife.
6. Use a soldering gun to splice conductors.
7. Cut and ream rigid conduit.
8. Use a volt ohmmeter.
9. _____

WRITTEN TEST SCORE _____

UNIT A3

4	3	2	1	0

Applied Skills

1. Given a list of terms associated with electrical skills, match them to their correct definitions.
2. Given incomplete statements, choose the words that correctly complete electricity safety guidelines.
3. Given a diagram, select the correct titles of major components of an AC power distribution system.
4. Complete statements that define the rules for simple series and parallel circuits.
5. From a list, choose those steps required to provide equipment grounding to devices and equipment within a power distribution system.
6. Select the correct methods to wire electrical receptacles, switches, and lighting.
7. Match electrical schematic symbols to their tables.
8. Install a duplex grounding type receptacle and a plate.
9. Wire a single pole switch and light.
10. Wire a receptacle fed from a lighting outlet through a single pole switch.
11. _____

WRITTEN TEST SCORE _____

Use of This Document

Use of this document can be used to record information about the student and the skills mastered by the student. This information is useful in documenting student progress during the training program and to provide information about the student's qualifications to potential employers and for entry into advanced training programs. Instructors using AGC-CIMC instructional materials are authorized to reproduce this document as required for use in their training programs.

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INTRODUCTION TO ELECTRICITY

CIMC

READING SKILLS

CIM

WRITI

	Reading Comprehension										Research and Reference										Functional Reading						Language		Composition									
UNITS OF INSTRUCTION	Gain factual information	Distinguish fact, opinion and inference	Recognize stereotyping and bias	Recognize propaganda	Analyze cause and effect	Draw conclusions	Make generalizations	React to written material	Apply word analysis techniques		Select useful resources	Locate resources	Find materials in library	Use standard references	Use in-book reference tools	Use audiovisual media	Use computer data base	Use magazines and newspapers			Interpret forms and records	Follow written instructions	Interpret graphics and symbols	Use content area vocabulary	Interpret abbreviations/acronyms	Read aloud		Use standard grammar and correct spelling, punctuation, and capitalization	State ideas clearly		Use complete sentences	Develop preliminary outline	Use topic sentences	Use introductory/closing paragraphs	Compose reports	Compose essays	Proofread and edit	Construct graphics and symbols	Take notes
1. Electrical Materials																							●	●													
2. Electrical Tools																					●	●															
3. Applied Skills																					●	●															

IC BASIC SKILLS DOCUMENTATION MATRI

TING SKILLS

MATH SKILLS

Research					Functional Writing							Operation and Calculation												Math Application										Data Analysis and Display											
Take notes	Use notecards	Create bibliography	Use footnotes	Outline material	Complete forms and records	Write instructions	Write letters	Write job applications	Write resumes	Use word processing	Use computer graphics	Round off numbers	Estimate answers	Use scientific notations	Use exponential notations	Calculate with whole numbers	Calculate with fractions	Calculate with decimals	Convert whole numbers to fractions	Convert whole numbers to decimals	Solve numerical expressions	Solve formulae and equations	Obtain squares and square roots	Convert units of measure	Perform metric calculations	Solve word problems	Select/apply mathematical formula	Select/apply mathematical procedure	Use English and metric measures	Solve time/rate/distance problems	Solve ratio/proportion problems	Solve percent problems	Apply techniques of scaling	Apply algebra principles	Apply geometry principles	Apply trigonometry principles	Interpret charts and tables	Interpret graphs (type)	Collect /record data	Apply sampling techniques	Apply principles of probability	Construct charts and tables	Construct graphs	Calculate statistics	Interpret statistics	Interpret blueprints/plans	Make measurements	Perform banking transactions	Make change

RIX

SCIENCE SKILLS

95-010909

Make measurements	Perform banking transactions	Make change	Solve practical problems	Calculate gross earnings	Solve income/expense problems	Prepare a budget	Calculate interest	Solve interest problems	Calculate sales tax	Determine income tax	Use calculator for computation	Use computer for computation	Use computer spreadsheets	Apply computing skills	Apply scientific method of inquiry	Conduct experiments	Investigate science ethics	Investigate science history	Investigate/apply economics in technology	Use scientific instruments	Investigate/apply technology	Collect specimens	Identify/classify living organisms	Investigate biological history of the earth	Investigate food chains, webs, pyramids	Investigate/apply principles of human development	Investigate/apply principles of genetics/heredity	Investigate/apply principles of anatomy/physiology	Investigate health issues	Analyze/classify matter	Investigate forms/changes of matter	Investigate forms/changes of energy	Investigate/apply chemical properties	Investigate/apply physical laws	Investigate physical characteristics of the earth	Investigate geological history of the earth	Investigate physical forces acting on the earth	Solve problems of longitude, latitude, and time zones	Investigate conservation of physical resources	Investigate conservation of living resources	Investigate issues of environmental impact	Apply science principles to environmental issues
Functional Math														General Science									Life Science							Physical Science							Earth Science							
•																•					•	•												•									

CIMC

ORAL COMMUNICATION SKILLS

INTERPERS

THE ASSOCIATED GENERAL CONTRACTORS OF AMERICA

UNITS OF INSTRUCTION

	Oral Presentation									Listening				Interactive Communication										General Relating									
	Make informative presentations	Make persuasive presentations	Present personal opinion/viewpoint	Use good speaking techniques	Select/use words effectively	Use effective body language	Present approriate appearance	Integrate audio and/or visual materials in oral presentations	Adapt presentation to specific audience	Apply active listening skills	Distinguish fact, opinion, and inference	Draw conclusions/make generalizations	Analyze/identify point of view	Give/follow oral directions	Apply questioning techniques	Conduct/receive interviews	Analyze/apply nonverbal communication	Work effectively in a group	Communicate with clients/customers/patients	Communicate with co-workers	Communicate with supervisors	Communicate with professional colleagues/ associates	Apply telephone etiquette	Investigate/apply communication process models	Analyze/apply nonverbal communication	Investigate/apply cross-cultural communication	Interact with co-workers	Interact with supervisors	Interact with clients/customers/patients	Interact with professionalcolleagues/associates	Interact with family/friends	Participate in group activities
1. Electrical Materials																																
2. Electrical Tools																																
3. Applied Skills																																

ERSONAL OR RELATING SKILLS

CREATIVE THINKING/ PROBLEM SOLVING SKILLS

EMP

| Teamwork Cooperation | | | | | | | | | | | | | | | Leadership Influence | | | | | | | | | | Cognitive Activities | | | | | | | | | | | | | | | Job Search Selection | | | | | | | | | | | | | | |

EMPLOYABILITY SKILLS

SOCIAL STUDIES SKILLS

arch tion					Job Aquisition Development										Information Analysis					Social Studies Application									Functional Social Studies								
Investigate benefits of a career field/occupation	Compare/evaluate career options	Develop personal career path	Locate appropriate jobs	Analyze duties/requirements/benefits of specific job	Master specific job task/procedure	Fill in job-related applications	Write letter of application	Write personal resume	Interview for a job	Apply business etiquette	Practice good work habits/attitudes	Develop good personal presentation	Develop self-confidence/esteem	Develop effective leadership	Deal effectively with supervisors	Deal effectively with co-workers	Deal effectively with professional colleagues/associates	Deal effectively with customers/clients	Collect/record data	Interpret graphical information	Construct graphical information	Interpret maps/globes	Interpret statistical information	Analyze/interpret demographic information	Investigate/apply U.S. history	Investigate/apply world history	Investigate/apply U.S. geography	Investigate/apply world geography	Investigate/apply principles of government/politics	Investigate/apply principles of economics	Investigate/apply principles of ethics	Investigate/apply principles of psychology	Investigate/apply principles of sociology	Investigate/apply cross-cultural studies	Practice responsible personal economics	Prepare a personal budget	Use credit responsibly	Practice good work ethics	Participate in industrial relations	Interact with people of different races/cultures	Investigate/participate in government	Investigate/apply American legal practices	Select/use sources of information on current events	Analyze current events	Analyze consumer issues	Analyze social issues	Analyze conservation/ecology issues	Analyze social impact of science/technology	Analyze economic impact of science/technology
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					●						●																																			